AECRU Contract Number N68711-00-D-0005
Delivery Order 0007

FINAL
FEASIBILITY STUDY FOR
INSTALLATION RESTORATION PROGRAM
SITES 2, 4, 8, AND 9
NAVAL BASE VENTURA COUNTY
POINT MUGU, CALIFORNIA

May 2004

Prepared for

DEPARTMENT OF THE NAVY
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FEASIBILITY STUDY
IRP SITES 2, 4, 8, and 9
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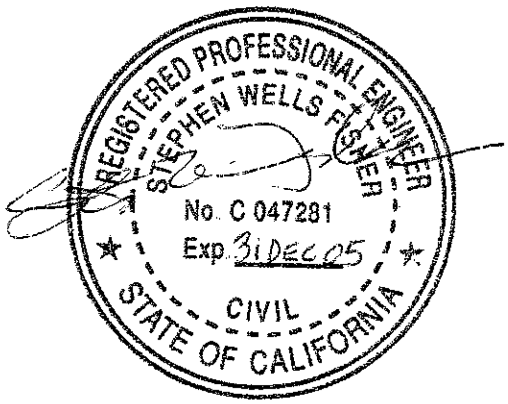
Professional Engineer Approval Page

The information contained in this report has received appropriate technical review and approval. The conclusions and recommendations presented represent professional judgments and are based upon the findings from the investigations identified in the report and the interpretation of such data based on our experience and background. This acknowledgment is made in lieu of all warranties, either express or implied.



CONTENTS

Appendix

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
Cal-EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cm/sec	Centimeters per second
CMECC	California Military Environmental Coordination Committee
COC	Chemical of concern
COE	U.S. Army Corps of Engineers
COPC	Chemical of potential concern
COPEC	Contaminant of potential ecological concern
CWA	Clean Water Act
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
DOE	U.S. Department of Energy
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
ECOS	Environmental Council of States
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentrations
FS	Feasibility study
FWS	U.S. Fish and Wildlife Service
HHRA	Human health risk assessment
HI	Hazard index

IAS	Initial assessment study
IC	Institutional control
IRP	Installation Restoration Program
JMM	James M Montgomery, Consulting Engineers, Inc.
JP	Jet propellant
LUC	Land use control
MCL	Maximum contaminant level
mgd	Million gallons per day
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MOA	Memorandum of agreement
msl	Mean sea level
NAS	Naval Air Station
NAWS	Naval Air Weapons Station
Navy	U.S. Department of the Navy
NBVC	Naval Base Ventura County
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No further action
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
ODD	Oxnard drainage ditch
OHM	OHM Remediation Services Corporation
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PP	Proposed plan
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation guideline
RACER	Remedial Action Cost Engineering and Requirements

ACRONYMS AND ABBREVIATIONS (Continued)

RAO	Remedial action objective
RAP	Remedial action plan
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial Investigation
RI/FS	Remedial investigation/feasibility study
RME	Reasonable maximum exposure
ROD	Record of decision
RSIP	Regional Shore Infrastructure Plan
RWQCB	Regional Water Quality Control Board, Los Angeles Region
SARA	Superfund Amendments and Reauthorization Act
SCS	Stearns, Conrad, and Schmidt
SI	Site inspection
SVOC	Semivolatile organic compound
TBC	To be considered
TCDD	Tetrachlorodibenzo-p-Dioxin
TDS	Total dissolved solid
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons
TtEMI	Tetra Tech EM Inc.
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UST	Underground storage tank
UWCD	United Water Conservation District
VOC	Volatile organic compound
West	McClelland Consultants, Inc.
WESTEC	WESTEC Services, Inc.

EXECUTIVE SUMMARY

This feasibility study (FS) addresses Installation Restoration Program (IRP) Sites 2, 4, 8, and 9 at Naval Base Ventura County (NBVC) Point Mugu as part of the U.S. Department of the Navy (Navy) IRP. The evaluations in this FS are based largely on sampling, findings, and conclusions from previous investigations and activities at NBVC Point Mugu. Most of the information about IRP Sites 2, 4, 8, and 9 was obtained from the final *Phase I Remedial Investigation, Technical Memorandum, Naval Air Weapons Station, Point Mugu, California* (referred to as the Phase I remedial investigation [RI]) (Tetra Tech EM Inc. [TtEMI] 2000) submitted in March 2000 and the final *Remedial Investigation for Groundwater Study, Naval Air Station, Point Mugu, California* (TtEMI 2004) submitted in January 2004.

This draft final FS was prepared by TtEMI in accordance with the IRP and the U.S. Environmental Protection Agency's (EPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (EPA 1988).

Background

IRP Sites 2, 4, 8, and 9 are located at NBVC Point Mugu, in Ventura County, California, about 50 miles northwest of Los Angeles. IRP Site 2, the old shops area, is a 30-acre area actively operated as a public works vehicle maintenance area. Disposal activities took place at this site from 1942 to 1980. During this period, wastes from site shops were spread on the surface for disposal. The wastes included battery acid, solvents, thinners, paint wastes, pesticide rinsate, and waste oil.

IRP Site 4, the public works storage yard, is a 12-acre site that was used to store vehicles, maintenance equipment, and maintenance parts. Between 1966 and 1970, transformers were serviced and maintained on site. Transformers, as well as waste chemical and oil drums, were also stored on the site. In 1997, contaminated soils were removed from the site, and it was restored as a wetland and bird habitat area.

IRP Site 8, the runway landfill, is about 4 acres in area, vegetated primarily with grasses. From the mid-1940s until 1952, it was used for trash burning and disposal of shop and household wastes. It is located adjacent to runway 9-27 in the overrun area.

IRP Site 9, the main base fire training area, is about 1.5 acres in size and contains two burn pits, one abandoned and one active. From the late 1950s until 1984, the original, abandoned burn pit was used for firefighter training exercises. Flammables burned during training exercises at this site included jet fuel, waste oils, hydraulic and transmission fluids, alcohol, carbon tetrachloride, paint thinners, and solvents. The active burn pit is still used for firefighter training.

Table ES-1 shows the previous investigations and actions performed at NBVC Point Mugu IRP Sites 2, 4, 8, and 9. It demonstrates the approach used to investigate the nature and extent of contamination in soils and groundwater at the sites, and lists the activities that led to this FS.

Based on the results of the Phase I RI (TtEMI 2000) and the RI for Groundwater (TtEMI 2004), IRP Sites 2, 4, 8, and 9 were recommended for limited further action to be addressed by an FS. The objective of this FS is to develop and evaluate appropriate alternatives to address soil and groundwater contaminants at each site.

This FS fulfills part of the Navy's commitment to follow the CERCLA process and to support the conclusions and recommendations of the Phase I RI (TtEMI 2000) and the RI for Groundwater (TtEMI 2004). The Navy also intends that the FS be used to support the preferred alternative. The preferred alternative for each site is intended as a final action and applies to the entire area of all the sites.

Results of the Remedial Investigation

As part of the Phase I RI (TtEMI 2000), physical data were compiled and used to evaluate the fate and transport of constituents in soil at IRP Sites 2, 4, 8, and 9. In the HHRA, analytical data were evaluated and chemicals of concern (COPCs) were identified. The excess lifetime cancer risks (ELCR) and the chronic toxicity hazard indices (HI) were then calculated.

EPA guidance on the role of the risk assessment in supporting risk management decisions is used in this FS to determine carcinogenic risk. According to the EPA directive memorandum regarding the *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA 1991), if cumulative carcinogenic risk to an individual based on reasonable maximum exposure (RME) for both current and future land use is less than 1×10^{-4} and the hazard quotient is less than 1, action is generally not warranted unless adverse environmental impacts are present. When risk exceeds 1×10^{-4}, remedial action goals are considered.

EPA has defined general remedial goals for sites on the National Priorities List (Title 40 of the Code of Federal Regulations [CFR] Part 300.430). These goals include a target risk range, which is defined as "an excess upperbound lifetime cancer risk to an individual from exposure to site contamination between 1×10^{-4} and 1×10^{-6}," or between 1 in 10,000 and 1 in 1,000,000. Consequently, carcinogenic risks within the target risk range of 1×10^{-4} and 1×10^{-6} are referred to as within a "risk management range" and are discussed in the risk characterization sections of this FS. In addition, a chemical of concern (COC) is identified when the risk for the chemical exceeds 1×10^{-6}, or if the hazard quotient exceeds 1. This information is reviewed to confirm that no site-specific conditions warrant further investigation or remediation.

TABLE ES-1: PREVIOUS INVESTIGATIONS AND ACTIONS AT NBVC POINT MUGU IRP SITES 2, 4, 8, AND 9

Feasibility Study for IRP Sites 2, 4, 8, and 9

IRP Site No.	IRP Site Name	Initial Assessment Study[a]		Preliminary Hydrogeologic Assessment[b]		Confirmation Study[c]		Site Inspection (Phases 1 and 2)[d]		Phase 1 RI/FS[e]	Removal Action	Phase I RI for Groundwater[f]
		Investigated	Recommended for Further Study	Investigated	Recommended for Further Study	Investigated	Recommended for Further Study	Investigated	Recommended for Further Study			
2	Old Shops Area	X	X					X	X	X		X
4	Public Works Storage Yard	X	X					X	X	X	X	X
8	Runway Landfill	X						X	X	X		X
9	Main Base Fire Training Area	X	X	X	X	X	X	X	X	X		X

Notes:

(a) Stearns, Conrad, and Schmidt (SCS) and Landau Associates 1985.
(b) Geotechnical Consultants, Inc. 1985.
(c) WESTEC Services, Inc. (WESTEC) and R.L. Stollar and Associates (Stollar) 1987.
(d) Fugro-McClelland 1991.
(e) TtEMI 2000.
(f) TtEMI 2004.

IRP Installation Restoration Program
RI Remedial Investigation
RI/FS Remedial Investigation/Feasibility Study

The human health risk assessment (HHRA) in the Phase I RI, and confirmed through additional evaluation in this FS, found that the estimated ELCRs from soil for IRP Sites 2 and 9 were between 1×10^{-4} and 1×10^{-6}, within the EPA's risk management range for residential and industrial workers at IRP Site 9 and for industrial workers based on a continued industrial land use scenario at IRP Site 2. At IRP Site 2, the only associated risk is to the current industrial worker, and was very close to the low end of the risk range with an RME of 1.7×10^{-6} from Arochlor 1260. Therefore, the Navy has made a risk management decision that no further action is necessary at Site 2. ELCRs for soil for IRP Site 8 were below the EPA's acceptable range of 1×10^{-6} for residential scenarios. The residential case was not made for IRP Site 4 because the site has already been restored to wetland and bird habitat. ELCRs for soil for IRP Site 4 were below the acceptable risk of 1×10^{-6} for the wildlife managers anticipated to frequent the site. IRP Site 4 is now a jurisdictional wetland that can never be used for either industrial or residential use. The RI for Groundwater (TtEMI 2004) concluded that there were no COPCs or COPECs in groundwater at these sites, nor direct pathways for human exposure to groundwater. Table ES-2 summarizes the results of the HHRA.

The concentrations of noncarcinogenic contaminants at all of the sites, as measured by their HIs, were found insufficient to cause noncancer adverse health effects. That is, HIs were below 1 for all sites. Finally, the ecological risk assessment showed that concentrations of contaminants at the sites were not sufficient to cause adverse environmental effects. Part of the proposed remedial action alternatives for IRP Site 9 include the implementation of land use controls (LUC) to maintain land use at this site as industrial. Deviation from industrial land use at IRP Site 9 would require reevaluation of the remedial alternatives.

Remedial Action Objectives

Information on IRP Site 9 was reviewed to determine the potential applicable or relevant and appropriate requirements (ARAR). Remedial action objectives (RAO) for IRP Sites 2, 4 and 8 were not developed because these sites pose no risk. These potential ARARs facilitated the selection of RAOs. The most appropriate and effective general response actions were determined based on their ability to comply with the ARARs and the ability to meet the RAOs.

Based on CERCLA, ARARs, and the Phase I RI HHRA (TtEMI 2000), the following RAOs were proposed for soil at IRP Site 9:

- Site 9 — prevent exposure of future residents to soil contaminated with carcinogens that result in an ELCR greater than 1×10^{-6}.

TABLE ES-2: HUMAN HEALTH RISK ASSESSMENT SUMMARIES

Feasibility Study for IRP Sites 2, 4, 8, and 9

Site 2		Total Cancer Risk	Total Hazard Index
Current Industrial Worker	Average	6.5×10^{-8}	NA
	RME	1.7×10^{-6}	NA
Future Industrial Worker	Average	2.9×10^{-8}	NA
	RME	3.3×10^{-7}	NA
Short-Term Construction Worker	Average	2.4×10^{-9}	NA
	RME	2.0×10^{-8}	NA
Resident	Average	3.3×10^{-7}	NA
	RME	8.4×10^{-7}	NA

Site 4				
Risk Value	Current Wildlife Management		Future Wildlife Management	
	Average	RME	Average	RME
Total Cancer Risk	1.8×10^{-8}	2.0×10^{-7}	5.6×10^{-8}	6.3×10^{-7}
Total Hazard Index	<0.005	<0.005	<0.005	<0.005

Site 8		Total Cancer Risk
Current Industrial Worker	Average	1.4×10^{-10}
	RME	1.9×10^{-9}
Future Industrial Worker	Average	2.2×10^{-10}
	RME	3.0×10^{-9}
Short-Term Construction Worker	Average	1.8×10^{-11}
	RME	2.7×10^{-10}
Resident	Average	3.8×10^{-9}
	RME	1.5×10^{-8}

Site 9		Total Cancer Risk	Total Hazard Index
Current Industrial Worker	Average	1.1×10^{-6}	<0.005
	RME	1.6×10^{-5}	0.02
Future Industrial Worker	Average	1.0×10^{-6}	<0.005
	RME	1.1×10^{-5}	<0.005
Sub-Area 9-1 Short-Term Construction Worker	Average	2.1×10^{-9}	<0.005
	RME	6.0×10^{-8}	0.02
Sub-Area 9-2 Short-Term Construction Worker	Average	5.2×10^{-9}	<0.005
	RME	6.6×10^{-8}	<0.005
Resident	Average	2.2×10^{-5}	<0.005
	RME	4.9×10^{-5}	<0.005

Based on CERCLA, ARARs, and the Phase I RI HHRA (TtEMI 2000), IRP Sites 2, 4 and 8 do not need remedial actions, and therefore do not have RAOs. However, in order to complete the CERCLA process, these sites are retained throughout the FS. RAOs were not proposed for groundwater at IRP Sites 2, 4, and 8, and 9 The RI for Groundwater (TtEMI 2004) concluded that there were no COPCs or COPECs in groundwater at these sites, nor direct pathways for human exposure to groundwater.

Screening of Remedial Action Alternatives

This FS reviews and discusses remedial alternatives for addressing soil and groundwater contaminants at IRP Sites 2, 4, 8, and 9. Alternatives were selected for evaluation based on their expected effectiveness for addressing contaminants identified during the Phase I RI and the RI for Groundwater. Identification of contaminants was based largely on the results of the approved HHRA and the ecological risk characterization prepared as part of the Phase I RI (TtEMI 2000), and the evaluation performed as part of this FS. As a result of the HHRA and the ecological risk characterization performed in the Phase I RI, no COCs were identified for soils or groundwater at IRP Sites 4 and 8. However, at Sites 2 and 9, COCs were identified in soils within the risk management range. In addition, the RI for Groundwater (TtEMI 2004) did not identify any COPCs or chemicals of potential ecological concern (COPEC) in groundwater at IRP Sites 2, 4, 8, and 9

All available information on IRP Site 9 was evaluated for the most appropriate and effective treatment alternatives. As mentioned previously, there are no risks associated with Sites 4 and 8 In addition, the Navy has made a risk management decision that the risk to current industrial workers at Site 2 does not require remedial action. Potential remedial measures for Site 9 were screened using effectiveness, implementability, and cost criteria. The effectiveness evaluation considered the ability of a remedial measure to protect human health and the environment, to comply with ARARs, and to meet RAOs The implementability criterion addressed the technical and administrative feasibility of implementing a remedial measure, and the cost criterion addressed the total cost of the measure Remedial measures retained after screening were used to formulate candidate remedial action alternatives for detailed evaluation. The following two remedial action alternatives were evaluated:

- Alternative 1: No further action (NFA)
- Alternative 2: LUCs

These alternatives were then evaluated based on the following nine criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume of contaminants
- Short-term effectiveness
- Implementability
- Cost

- State acceptance
- Community acceptance

Feasibility Study Recommendations

IRP Sites 2, 4, 8 and 9 were grouped together in this FS because conclusions developed in the RI stated that these sites require no action or land use controls only. Results of the FS show that there are no associated risks at Sites 4 and 8, and risks at Sites 2 and 9 are in the risk management range. The Navy has made a risk management decision that no further action is necessary at Site 2. However, because there are no restrictions to future land use at Site 9, the Navy is recommending implementation of land use controls.

Alternative 1, NFA, is the recommended alternative for IRP Sites 2, 4 and 8. Alternative 2, LUCs, is the recommended alternative for IRP Site 9. This alternative protects human health and the environment and complies with ARARs, as well as offers the best balance of the other evaluation criteria. Table ES-3 summarizes the preferred actions for each site in this FS, and the rationale for its selection.

The evaluation of criteria in this FS attempted to weigh all considerations. However, it is not possible to know all of the community concerns at this time. The FS will be available for public review, and comments will be addressed.

TABLE ES-3: RECOMMENDATIONS FOR NBVC POINT MUGU IRP SITES 2, 4, 8, AND 9

Feasibility Study for IRP Sites 2, 4, 8, and 9

Site	Proposed Action	Rationale
IRP Site 2	No Further Action	The HHRA in the Phase I RI found that the estimated ELCRs for IRP Site 2 was between 1×10^{-4} and 1×10^{-6}; that is within EPA's risk management range for industrial workers. Therefore, the Navy has made a risk management decision that no further action is necessary for Site 2. The HHRA in the Phase I RI also found that concentrations of noncarcinogenic contaminants at this site, as measured by the HI, were insufficient to cause noncancer adverse health effects. That is, HIs were below 1. The ecological risk assessment showed that concentrations of contaminants at this site were not sufficient to cause adverse environmental effects.
IRP Site 4	No Further Action	IRP Site 4 is already restored as a wetland and bird habitat. Thus, the ELCR for the site was estimated for wildlife managers at the site. The HHRA in the Phase I RI found that the estimated ELCR for IRP Site 4 was below EPA's acceptable range for wildlife managers at the site. The HHRA in the Phase I RI also found that concentrations of noncarcinogenic contaminants at the sites, as measured by an HI, were insufficient to cause noncancer adverse health effects. That is, the HI for IRP Site 4 was below 1. The ecological risk assessment showed that concentrations of contaminants at the site were not sufficient to cause adverse environmental effects. Furthermore, the site is designated as a wetland in perpetuity, therefore assuring no industrial or residential use.
IRP Site 8	No Further Action	The HHRA in the Phase I RI found that the estimated ELCR was below EPA's acceptable range for IRP Site 8. The ELCR for IRP Site 8 was estimated using a residential scenario and the assumptions for child and adult residents. The HHRA in the Phase I RI also found that concentrations of noncarcinogenic contaminants at IRP Site 8, as measured by an HI, were insufficient to cause noncancer adverse health effects. That is, the HI for IRP Site 8 was below 1. The ecological risk assessment showed that concentrations of contaminants at the site were not sufficient to cause adverse environmental effects.

TABLE ES-3: RECOMMENDATIONS FOR NBVC POINT MUGU IRP SITES 2, 4, 8, AND 9
Feasibility Study for IRP Sites 2, 4, 8, and 9

Site	Proposed Action	Rationale
IRP Site 9	Institutional Land Use Controls for Industrial Purposes	The HHRA in the Phase I RI found that the estimated ELCRs for IRP Site 9 was between 1×10^{-4} and 1×10^{-6}; that is within EPA's risk management range for industrial workers. However, there are no restrictions on land use at Site 9 to prevent residential land use and exposure. The HHRA in the Phase I RI also found that concentrations of noncarcinogenic contaminants at this site, as measured by the HI, were insufficient to cause noncancer adverse health effects. That is, HIs were below 1. The ecological risk assessment showed that concentrations of contaminants at the site were not sufficient to cause adverse environmental effects.

Notes:
ELCR Excess lifetime cancer risk
HI Hazard Index
RI Remedial Investigation
EPA U.S. Environmental Protection Agency
IRP Installation Restoration Program
HHRA Human Health Risk Assessment
NBVC Naval Base Ventura County

1.0 INTRODUCTION

The U S Department of the Navy (Navy), Southwest Division, Naval Facilities Engineering Command conducted this feasibility study (FS) for Installation Restoration Program (IRP) Sites 2, 4, 8, and 9 at Naval Base Ventura County (NBVC) Point Mugu, California. The FS was prepared by Tetra Tech EM Inc. (TtEMI) in accordance with the scope of work under Delivery Order No. 0007 of Contract Number N68711-00D-0005, the Indefinite Quantity Contract for Architectural-Engineering Services to Provide Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Resource Conservation and Recovery Act (RCRA)/underground storage tank (UST) Studies The FS was conducted in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. Environmental Protection Agency [EPA] 1988).

The FS is based primarily on information contained in the following documents:

- The Final "Phase I Remedial Investigation (RI), Technical Memorandum, Naval Air Weapons Station Point Mugu, California" (Phase I RI) (TtEMI 2000)
- The Final "Remedial Investigation for Groundwater Study, Naval Air Station, Point Mugu, California" (RI for Groundwater) (TtEMI 2004)
- "Removal Action at Installation Restoration Program Sites 1, 4, 7, 9, and 11, Naval Air Weapons Station, Point Mugu, Point Mugu, California, Final Work Plan" (OHM Remediation Services Corporation [OHM] 1996)
- "Removal Action at Installation Restoration Program Sites 1, 4, 7, 9, and 11, Naval Air Weapons Station, Point Mugu, Point Mugu, California, Final Removal Action Documentation Report" (OHM 1997)

Section 1.0 presents the purpose and organization of this FS

1.1 PURPOSE

This FS develops and evaluates potential response actions to address the environmental concerns identified for soil and groundwater at the sites. It further selects and evaluates remedial alternatives to facilitate closure of IRP Sites 2, 4, 8, and 9 in accordance with the Navy CERCLA process. The Navy CERCLA process is shown on Figure 1-1.

This FS will be used as the basis for a future CERCLA remedial action. The Navy, with state regulatory oversight, is the lead agency for the remedial action. As the lead agency, the Navy with state concurrence has final approval authority for both the selected remedial alternative and community involvement. The Navy is working with the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances (DTSC); the Cal-EPA Regional Water Quality Control Board, Los Angeles Region (RWQCB); and the California Department of Fish and Game in implementing the CERCLA remedial action.

1.2 ADMINISTRATIVE HISTORY

TtEMI completed the Phase I RI at IRP Sites 2, 4, 8, and 9 at NBVC Point Mugu in March 2000 (TtEMI 2000). TtEMI completed the RI for Groundwater at IRP Sites 2, 4, 8, and 9 in January 2004 (TtEMI 2004). A draft version of this FS was completed and submitted in October 2001. This draft final FS responds to and incorporates regulatory agency comments on the draft document. A formal response to comments is provided in Appendix A. In addition, the Navy and regulatory support agencies met in August 2003 to discuss the FS, results of additional evaluation completed for this FS, and alternatives for IRP Sites 2, 4, 8, and 9. Formal meeting minutes are provided in Appendix B.

IRP Sites 2, 4, 8 and 9 were grouped together for this FS because conclusions developed in the RI stated that these sites require no action or only require land use controls (LUCs). After receiving comments from the agencies on the Draft FS, the Navy submitted responses to comments in August, 2003. In the same month, the Navy and the agencies met to agree on no further action determinations for this FS. As shown in the meeting minutes in Appendix B, the Navy and the agencies agreed that no further action is required for Sites 4 and 8. The agencies also agreed to the risk calculation at Site 2 and that the risk of 1.7×10^{-7} is acceptable to the current industrial worker. Site 9 risk results, though in the risk management range (the greatest risk at 4.9×10^{-5} to the future adult and child resident) requires further action. As a result of the meeting, this FS includes all four sites to maintain consistency throughout the CERCLA process. As discussed further in this document, the Navy proposes LUCs for Site 9 because there are human health risks within the risk management range at the site and no action for Sites 2, 4 and 8

Table 1-1 shows the chronological order of environmental activities already performed at IRP Sites 2, 4, 8, and 9. The table demonstrates the approach used to investigate the nature and extent of contamination at the sites, and specifies the activities that led to the FS.

1.3 ORGANIZATION

Section 2.0 of the FS summarizes the data collected for IRP Sites 2, 4, 8, and 9 during site characterization activities. These data, including information on the location, history, and regional setting of NBVC Point Mugu, were taken from the Phase I RI (TtEMI 2000) and the RI for Groundwater (TtEMI 2004).

Section 3 summarizes the nature and extent of soil and groundwater contamination at IRP Sites 2, 4, 8, and 9. It also discusses and presents the results of the human health risk assessments (HHRA) and the ecological risk characterizations performed as part of the Phase I RI and for this FS. Finally, it summarizes the site risks.

Section 4.0 defines and discusses applicable or relevant and appropriate requirements (ARAR), and then identifies the potential federal and state ARARs for the remediation of IRP Site 9. It also identifies the remedial action objectives (RAO) for soil at IRP Site 9. RAOs were not established for IRP Sites 4 and 8 because there were no risks. RAOs were not determined for Site 2 because the Navy has made a risk management decision that the site risks do not warrant further action. RAOs were not proposed for groundwater at IRP Sites 2, 4, 8, and 9 because the RI for Groundwater (TtEMI 2004) concluded that there are no chemicals of potential concern (COPC) or chemicals of potential ecological concern (COPEC) in groundwater at these sites, and the Phase I RI (TtEMI 2000) concluded that there are no pathways for direct human exposure to groundwater.

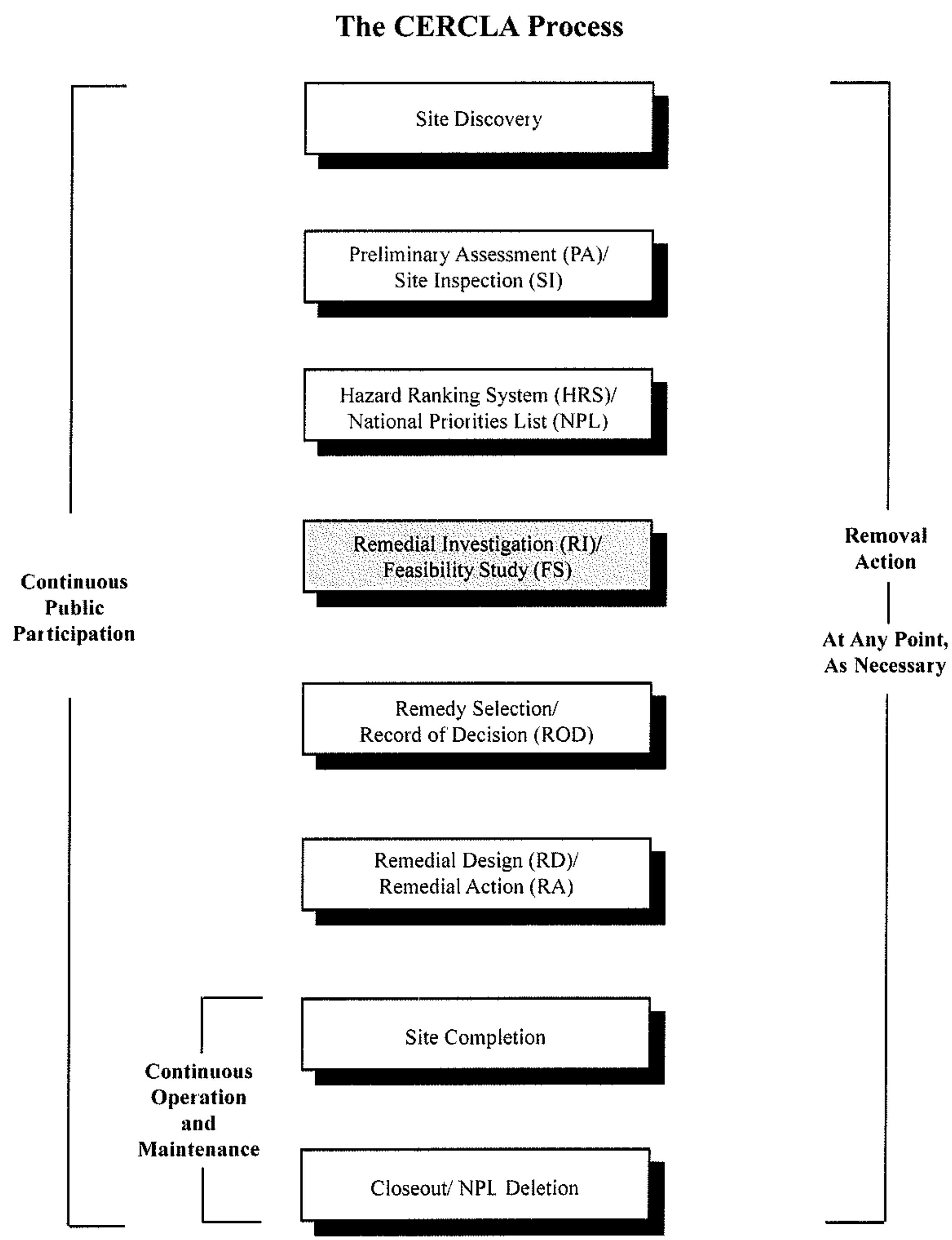
Section 5.0 screens potential remedial measures for effectiveness, implementability, and cost, and selects specific response actions and methods as remedial alternatives for more detailed evaluation.

Section 6.0 defines and discusses nine evaluation criteria and provides a detailed analysis of selected remedial alternatives according to the nine criteria. It also uses the evaluation criteria to evaluate and compare the remedial alternatives against one another.

Section 7.0 summarizes the evaluation of alternatives and, based on the comparative analysis, recommends a preferred action for each site.

Section 8.0 provides references for the documents cited in the FS.

FIGURES



Tetra Tech EM Inc.

NBVC POINT MUGU, CALIFORNIA
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 1-1
U.S. DEPARTMENT OF THE NAVY
INSTALLATION RESTORATION PROGRAM
CERCLA PROCESS
Final FS IRP Sites 2, 4, 8, & 9

Note: Shading indicates where this document is located in the CERCLA process

Fig 1-1_cercla process.pmd - 06/11/2003 - G9016.007 04 12 02 04 18

TABLES

TABLE 1-1: PREVIOUS INVESTIGATIONS AND ACTIONS AT NBVC IRP SITES 2, 4, 8, AND 9

Feasibility Study for IRP Sites 2, 4, 8, and 9

IRP Site No.	IRP Site Name	Initial Assessment Study[a]		Preliminary Hydrogeologic Assessment[b]		Confirmation Study[c]		Site Inspection (Phases 1 and 2)[d]		Phase 1 RI[e]	Removal Action	RI for Groundwater[f]
		Investigated	Recommended for Further Study	Investigated	Recommended for Further Study	Investigated	Recommended for Further Study	Investigated	Recommended for Further Study			
2	Old Shops Area	X	X					X	X	X		X
4	Public Works Storage Yard	X	X					X	X	X	X	X
8	Runway Landfill	X						X	X	X		X
9	Main Base Fire Training Area	X	X	X	X	X	X	X	X	X		X

Notes:

(a) Stearns, Conrad, and Schmidt (SCS) and Landau Associates 1985.
(b) Geotechnical Consultants, Inc. 1985.
(c) WESTEC Services, Inc. (WESTEC) and R.L. Stollar and Associates (Stollar) 1987.
(d) Fugro-McClelland 1991.
(e) TtEMI 2000a.
(f) TtEMI and LFR 2002.

IRP Installation Restoration Program
RI Remedial Investigation
RI/FS Remedial Investigation/Feasibility Study

2.0 SITE CHARACTERIZATION

The information in Section 2.0, except as noted, was excerpted from the final Phase I RI (TtEMI 2000) and the final RI for Groundwater (TtEMI 2004). These reports contain most of the information needed for site characterization for the FS.

2.1 LOCATION AND HISTORY

NBVC Point Mugu is located in Ventura County, California, about 50 miles northwest of Los Angeles (Figure 2-1). It is bordered by Highway 1 on the north and east, by the Pacific Ocean on the south and west, and by the Ventura County game reserve on the west and northwest, as shown in Figure 2-2.

NBVC Point Mugu comprises about 4,500 acres and contains 897 buildings, including 568 housing units. Many buildings were constructed on dredged material and other fill. NBVC Point Mugu employs more than 9,000 personnel, including 2,427 military personnel, 4,157 civilian personnel, and about 2,500 contractors.

The Navy established temporary operations at Point Mugu, California in 1944, and has conducted operations there since 1945. The Naval Air Missile Test Center was commissioned at Point Mugu in 1946, and the U.S. Naval Air Station was commissioned in 1949. Funding for a permanent Navy site at Point Mugu was appropriated by Congress in 1947. The Pacific Missile Test Range was established in 1957, and was renamed the Pacific Missile Test Center in the mid-1970s. In 1993, the names were revised again: the Pacific Missile Test Center became the Naval Air Warfare Center Weapons Division; and the U.S. Naval Air Station became the Naval Air Weapons Station (NAWS). In 1998, the name NAWS Point Mugu was changed back to Naval Air Station (NAS) Point Mugu as a result of changes in military operations at the base. In 2000, the name was changed to its present NBVC Point Mugu.

NBVC Point Mugu is a major center for naval weapons systems testing and evaluation. In addition, it provides range, technical, and base support for fleet users and other U.S. Department of Defense (DOD) agencies.

NBVC Point Mugu currently maintains a fleet of more than 50 aircraft, many of which are uniquely configured to support the assigned test and evaluation mission for airborne weapons and electronic warfare systems. Aircraft are also used for mobile range instrumentation, range surveillance and clearance, target launch and recovery, and logistic support. The largest and most varied inventory of airborne targets in the Navy is maintained at NBVC Point Mugu. The naval base also provides target support for the mobile sea range operation around the world and, upon request, at other test ranges that need sophisticated threat simulation support.

2.2 REGIONAL AREA AND SETTING

This section describes NBVC Point Mugu and the surrounding area, including climate, topography, geology, hydrogeology, land use, ecological characteristics, and cultural resources.

2.2.1 Climate

The climate of the Ventura Basin around NBVC Point Mugu is heavily influenced by the Pacific Ocean. Summers are generally dry. However, in winter months, moist air from the ocean is carried inland and forced upward by the Santa Monica and Santa Ynez mountains, and thus, creates storms. Temperature, humidity, precipitation, and cloud cover throughout the area vary as a result of topography.

The climate in the vicinity of NBVC Point Mugu is, likewise, influenced by the coastal setting. It is moderately humid. Winters are mild and moist. Summers are warm and dry (Fugro-McClelland 1991). Climatological data from NBVC Point Mugu weather station shows an average annual temperature of 59.3°F (Fisk and Cohenour 1993). The average minimum monthly temperature ranges from 44.5°F in January to 58.5°F in August. The average maximum monthly temperature ranges from 63.6°F in January to 73.0°F in September. The average monthly humidity ranges from a minimum of 64 percent to a maximum of 82 percent.

Ninety-two percent of the rain at NBVC Point Mugu falls between the months of November and April (Steffen 1982). The average annual precipitation is 11.84 inches. The minimum monthly average, 0.01 inch, occurs in July. The maximum monthly average, 2.72 inches, occurs in January. However, in the winter months of 1997 and 1998, NBVC Point Mugu received 31.81 inches of rain, more than 300 percent of the normal rainfall for the area. The 100-year maximum 24-hour rainfall at NBVC Point Mugu is 5.05 inches (Fisk and Cohenour 1993).

Wind speeds and directions in the vicinity of NBVC Point Mugu show clear seasonal variations. From March through September, westerly to northwesterly onshore winds are dominant from mid-morning through early evening. Nighttime and early morning breezes are very weak. The onshore summer winds are typically 4 to 10 knots, but they can be significantly stronger in March, April, and May. From October through February, moderate, northeasterly, offshore winds of 4 to 10 knots are typical during the night and morning. In the afternoon, these winds change to become somewhat stronger, westerly, onshore winds.

2.2.2 Topography

NBVC Point Mugu is located in the southern part of the Oxnard Plain, which is part of the Ventura Basin (Figure 2-3). The Oxnard Plain is generally flat, with a slight increase in elevation inland (northward). The Santa Monica and Santa Ynez Mountains, which form the eastern and northern boundaries of the Ventura Basin, respectively, rise abruptly from the Oxnard Plain to elevations of more than 1,000 feet.

Like the Oxnard Plain, the ground surface at NBVC Point Mugu is relatively flat, with elevations predominantly ranging from sea level to about 11 feet above mean sea level (msl) (Stearns, Conrad, and Schmidt [SCS] and Landau Associates 1985). At one isolated area in the south-central part of the naval base, the elevation rises to about 26 feet above msl.

Mugu Lagoon presently occupies about 311 acres in the southern part of NBVC Point Mugu. Including intertidal flats, salt marsh, and salt ponds, the lagoon occupies 1,445 acres of land. Mugu Lagoon is presently a marine-dominated system. It receives significant tidal inflow from the Pacific Ocean as well as freshwater inflow from Calleguas Creek. Many of the drainage ditches are also inundated by tidal inflows. Prior to 1884, however, land-derived sediments contributed little to the lagoon, and the area probably resembled a coastal marine marsh. In 1884, after crop agriculture was established on the Oxnard Plain, Calleguas Creek was channelized, and its flow was diverted into the lagoon (Onuf 1987).

The present configuration of Mugu Lagoon (Figure 2-4) results from the channelization and diversion of Calleguas Creek. In addition, some parts of the lagoon were filled in order to construct NBVC Point Mugu facilities, and the central part of the lagoon, near the mouth of Calleguas Creek, was dredged (SCS and Landau Associates 1985).

Mugu Lagoon presently consists of two arms, the east and the west arms, that project out from a broader, central basin. The boundaries of the lagoon vary seasonally and are also heavily influenced by tidal levels and the quantity of fresh water entering from Calleguas Creek, Revolon Slough, and other tributaries, such as the Oxnard drainage ditches.

In 1992, extreme westward erosion of the barrier sand spit near the mouth of the lagoon occurred. This erosion modified the lagoon shoreline in areas that were previously protected from wave action. Increased sedimentation in the eastern part of the central basin caused a lengthening of the eastern arm of the lagoon (Navy 1993). In addition, winter storms in January and February, 1995 altered the bathymetry of the southern part of the western area of the lagoon and the configuration of the mouth of the lagoon.

Mugu Lagoon is generally less than 10 feet deep at high tide. Circulation patterns within the lagoon are characterized by slow water mixing and flushing rates in the extreme western part of the lagoon and moderate to fast mixing and flushing rates in the eastern and central parts of the lagoon. Flushing rates are determined by tidal influence and the quantity of fresh water entering the lagoon from Calleguas Creek, Revolon Slough, and other tributaries, such as the Oxnard drainage ditches (McClelland Consultants, Inc. [West] 1990).

Mugu Lagoon receives sediment from its tributaries and from tidal action. The estimated average annual sediment yield to Mugu Lagoon from Calleguas Creek is 240,000 tons (U.S. Department of Agriculture [USDA] Soil Conservation Service and Forest Service 1994). Sedimentation rates increase during storms because runoff increases flows in Calleguas Creek and other tributaries. Most sediment enters the lagoon in suspension and then settles, because flow velocities in the lagoon are low. Based on the average annual sedimentation rate, the USDA Soil Conservation Service, now Natural Resource Conservation Service, predicts that almost all of the open water areas of the lagoon will disappear within 50 years and that Mugu Lagoon will become a coastal plain within 100 years (Steffen 1982).

2.2.3 Geology

NBVC Point Mugu lies at the southern end of Ventura Basin, a sedimentary basin located within the Transverse Ranges geomorphic province. Figure 2-5 is a geological map of Ventura Basin. The Transverse Ranges province consists of highlands, basins, and east-west-trending folds that resulted from regional strike-slip and thrust faulting (Mukae and Turner 1975; Fugro-McClelland 1991).

The Ventura Basin lies immediately west of the foot of the Santa Monica Mountains, which are composed of Miocene-age volcanic and marine deposits of the Topanga Formation. The basin is filled with more that 40,000 feet of sediments, resulting in a broad coastal lowland, the Oxnard Plain. Table 2-1 presents the stratigraphy of the Ventura Basin south of the Santa Clara River. As shown in Figure 2-5, most of the Oxnard Plain is covered in Holocene alluvium and unconsolidated water-bearing Pleistocene sediments.

A probable concealed fault, the Bailey Fault, is interpreted to separate the Ventura Basin from the Santa Monica Mountains. The fault is thought to be located along the approximate axis of Calleguas Creek, which runs along the foot of the Santa Monica Mountains (Fugro-McClelland 1991). The alluvium is underlain by additional unconsolidated water-bearing soils and sediments called the San Pedro Formation (lower Pleistocene) and the Santa Barbara Formation (lower Pleistocene to Pliocene).

The total thickness of these unconsolidated sediments ranges from 600 feet at NBVC Point Mugu to more than 2,000 feet near the Santa Clara River. Beneath the unconsolidated sediments are thousands of feet of consolidated sediments and volcanics, as shown in Table 2-1.

Ventura Basin has been subjected to periods of deformation and erosion throughout its history. It contains several unconformities, as indicated in Table 2-1. Figure 2-6 shows a generalized geologic cross-section of the Oxnard Plain from NBVC Point Mugu northwest toward Ventura, California.

The unconsolidated Pleistocene to Holocene sediments in the vicinity of NBVC Point Mugu range from 900 to 2,300 feet thick and consist of alluvial clays, silts, sands, and gravels. The deposits occur as both laterally continuous layers and lenticular beds. The uppermost soils and sediments range between the surface and 85 to 135 feet below ground surface (bgs). They consist primarily of sand, silt, and clay.

The shallow soils and sediments at NBVC Point Mugu were deposited in stream and tidal lagoon depositional environments, including river, stream, and creek channels and bars; deltaic mud flats, ponds, and channels; and tidal lagoon marshes and ponds. Soils and sediments are virtually indistinguishable at NBVC Point Mugu except for their current locations and organic material content. Historic depositional areas have shifted numerous times, and soils and sediments are intermingled.

Geomorphic features at NBVC Point Mugu include 290 acres of ocean beach and dunes; 311 acres of subtidal lagoons, ponds, and channels; 123 acres of intertidal flats; and 1,011 acres of salt marsh and salt ponds. The remaining acres are open space and developed areas.

Much of the land of NBVC Point Mugu was formed from mechanically compacted fill material. The distribution of surficial soils is shown in Figure 2-7. Fill material underlies most of the developed areas of the naval base. Fill thickness and composition vary widely (Fugro-McClelland 1991).

2.2.4 Hydrogeology

This section discusses the hydrostratigraphy, groundwater flow directions, groundwater discharge and recharge, seawater intrusion of the aquifer systems of the Oxnard Plain and NBVC Point Mugu, and the relationships among the aquifers. It also discusses surface water hydrology.

2.2.4.1 Hydrostratigraphy

Six aquifers have been identified within Pleistocene- to Holocene-age deposits in the Ventura Basin. In order of increasing depth, they are the unconfined aquifer, the Oxnard, the Mugu, the Hueneme, the Fox Canyon, and the Grimes Canyon aquifers. The shallow, unconfined aquifer is called the "semi-perched aquifer." The aquifers are separated by aquitards that are leaky and discontinuous across the Ventura Basin (SCS and Landau Associates 1985). Together, the Oxnard and the Mugu aquifers form the upper aquifer system. The Hueneme, the Fox Canyon, and the Grimes Canyon aquifers comprise the lower aquifer system.

Table 2-2 presents the hydrostratigraphy of the five aquifers beneath NBVC Point Mugu. The Hueneme aquifer is absent from beneath NBVC Point Mugu (SCS and Landau Associates 1985). Figure 2-8 is a fence diagram showing the various hydrogeologic cross sections at NBVC Point Mugu. It is based on the interpretation of the stratigraphic and water level data from the wells in the upper and lower aquifer systems.

Unconfined Aquifer

The shallow, unconfined aquifer is contained within Holocene-age deposits. It extends from the water table to an average depth of 75 feet bgs over most of the Oxnard Plain (SCS and Landau Associates 1985). It is composed of fluvial deposits of sand and gravel interbedded with silt and clay (Department of Water Resources [DWR] 1965). Groundwater quality in the unconfined aquifer is low, and water from the aquifer is not generally used for either domestic or agricultural purposes.

Within the Oxnard Plain, the unconfined aquifer is separated from the Oxnard aquifer by an aquitard called the "clay cap." This aquitard consists of silt and clay with lenses of fine- to medium-grained sand. The thickness of the clay cap generally ranges between 10 and 100 feet thick. Within the Ventura Basin, it attains a maximum thickness of 160 feet. Generally, this aquitard is of low permeability, although zones of relatively high permeability may exist and allow downward groundwater flow (DWR 1965).

At NBVC Point Mugu, the unconfined aquifer extends from the water table (about 2 to 10 feet bgs) to the top of the clay cap aquitard. This aquitard separates the unconfined aquifer from the underlying Oxnard aquifer. The depth to the top of the aquitard ranges from about 85 to 135 feet bgs.

The unconfined aquifer consists of layered sands, silts, and clays. Lithologic logs of U.S. Geological Survey (USGS) well borings (see Appendix A, TtEMI 2000) show the aquitard that separates the unconfined aquifer from the Oxnard aquifer as a silt and clay layer that may be up to 20 feet thick. However, cone penetrometer testings (see Appendix B, TtEMI 2000) show the aquitard to be 20 to 40 feet thick.

The aquitard that separates the unconfined aquifer from the Oxnard aquifer is likely to be both laterally and vertically discontinuous in some areas. Therefore, the unconfined and the Oxnard aquifers may be in hydraulic communication. However, data on water level, geochemistry, and stable isotopes, as well as hydraulic conductivity, collected during the RI for Groundwater (TtEMI 2004) showed reasonable separation between the aquifers. The hydraulic conductivity values of the aquitard were on the order of 1×10^{-7} centimeters per second (cm/sec).

Oxnard Aquifer

The Oxnard aquifer is a confined aquifer located between 100 and 330 feet bgs. It is the principal aquifer beneath Oxnard Plain and a major producer of high-quality groundwater. As recently as the early 1990s, however, seawater intrusion was induced in the aquifer by pumping. New facilities and management practices have slowed, and even repelled, intrusion in some areas. However, the recent recovery is not an assurance that the landward migration of seawater will not recur if groundwater extraction exceeds recharge (United Water Conservation District [UWCD] 1996 and 1998).

The Oxnard aquifer consists of Holocene-age fine- to coarse-grained sand and gravel. Interbedded silt and clay layers separate the aquifer into several zones. The Oxnard aquifer is generally separated from the underlying Mugu aquifer by an aquitard consisting of silt and clay of very low permeability. This aquitard ranges in thickness from 10 to 100 feet across the Oxnard Plain (DWR 1965).

In the northern part of the Oxnard Plain, just south of the Santa Clara River, in an area called the Oxnard Plain Forebay, the clay cap aquitard that separates the Oxnard aquifer and the unconfined aquifer is absent. Consequently, the Oxnard aquifer and the unconfined aquifer are hydraulically connected in this area.

At NBVC Point Mugu, the Oxnard aquifer is a confined aquifer located between about 125 and 175 feet bgs. It ranges between about 35 and 115 feet in thickness, as estimated from resistivity data and lithologic logs from USGS well borings (TtEMI 2000). The Oxnard aquifer is separated from the Mugu aquifer by a low-permeability aquitard that consists of silt and clay and that ranges in thickness from about 35 to 100 feet thick.

Mugu Aquifer

The Mugu aquifer is a confined aquifer within upper Pleistocene-age deposits. It is located about 300 to 500 feet bgs. The aquifer is about 200 feet thick and is characterized by fine- to coarse-grained sand and fine gravel with local interbedded silt and clay. The aquifer has moderate to high hydraulic conductivity, and water supply wells have been completed in this aquifer in the vicinity of NBVC Point Mugu. Beneath the Mugu aquifer is an aquitard of silt and clay up to 200 feet thick (Fugro-McClelland 1991).

The Mugu aquifer consists of one to three confined aquifer zones at different parts of NBVC Point Mugu. Each of the zones has a different hydraulic head (TtEMI 2000). The zones are found at about 275 to 340 feet bgs in the northern part of NBVC Point Mugu (one aquifer zone) and at about 275 to 315 feet bgs in the southwest part (three aquifer zones). The zones are separated by low-permeability layers of silt and clay.

At NBVC Point Mugu, the Hueneme aquifer is absent. The Mugu aquifer is separated from the Fox Canyon aquifer by a low-permeability aquitard consisting of silt and clay and ranging in thickness from about 35 to 200 feet.

Hueneme Aquifer

The Hueneme aquifer is generally located below the Mugu aquifer in the Oxnard Plain. It occurs between 400 and 1,500 feet bgs. The Hueneme aquifer is absent beneath NBVC Point Mugu.

The Hueneme aquifer is the uppermost unit of the lower aquifer system. It is composed of as much as 1,100 feet of sand, silt, and clay in the deepest part of the Ventura Basin. The aquifer varies from 0 to 1,000 feet thick. It has been subjected to folding and erosion, which has caused it to be very thick in some places and absent in others

Fox Canyon and Grimes Canyon Aquifers

The Fox Canyon and Grimes Canyon aquifers are confined and lie below the Hueneme aquifer. The Fox Canyon aquifer consists of 100 to 200 feet of fine- to medium-grained sand and gravel with interbedded silt and clay. The aquifer has a relatively high permeability. It is the principal lower Pleistocene aquifer.

A thin aquitard consisting of silt and clay separates the Fox Canyon aquifer from the underlying Grimes Canyon aquifer. The aquitard may not be laterally continuous, and thus, may allow hydraulic continuity between the two aquifers (SCS and Landau Associates 1985). The Grimes Canyon aquifer consists of fine- to coarse-grained sand and gravel. It has a relatively high permeability. Only a few deep wells have reached the Grimes Canyon aquifer.

Turner (1975) suggests the presence of the Fox Canyon and Grimes Canyon aquifers beneath the Mugu aquifer at NBVC Point Mugu. However, two separate aquifers cannot be hydraulically distinguished using groundwater-level data from the deep-nested wells. Therefore, the aquifer zone beneath the Mugu aquifer at NBVC Point Mugu is not differentiated and is discussed as the Fox Canyon and Grimes Canyon aquifers.

The top of this aquifer zone is at a depth of about 350 feet bgs in the northern part of NBVC Point Mugu. In the southwestern part, the top is found at about 725 feet bgs. The bottom of the Fox Canyon and Grimes Canyon aquifers is not known at NBVC Point Mugu because none of the wells is sufficiently deep to identify the bottom boundary. In the northern part of NBVC Point Mugu, the aquifer zone is at least 600 feet thick (TtEMI 2000).

2.2.4.2 Groundwater Flow Directions

This section discusses the groundwater flow directions for the aquifer systems of the Oxnard Plain.

Unconfined Aquifer

Most agricultural and municipal wells in the Oxnard Plain are completed in the upper and lower aquifer systems. Therefore, information on the regional groundwater flow of the shallow, unconfined aquifer is limited.

At NBVC Point Mugu, groundwater in the unconfined aquifer generally flows to the north-northeast in the northwestern half of the naval base, and to the southeast-east, toward Mugu Lagoon, in the remainder of the naval base. Typical groundwater elevations range from 0.5 feet below msl to 2.2 feet above msl. The horizontal groundwater gradient is relatively flat in the central part of the naval base, and becomes steeper as groundwater nears Mugu Lagoon and Oxnard drainage ditch (ODD) No. 2.

Groundwater flow in the unconfined aquifer is influenced by tidal fluctuations, and may also be influenced by groundwater extraction from the Oxnard aquifer (Fugro-McClelland 1991; PRC Environmental Management, Inc. [PRC] and James M. Montgomery, Consulting Engineers, Inc. [JMM] 1992; TtEMI 2000). The upper part of the unconfined aquifer probably discharges primarily to surface water. Recharge of the aquifer is primarily through infiltration of precipitation.

Upper Aquifer System

The Mugu and Oxnard aquifers comprise the upper aquifer system. Figure 2-9 shows the groundwater elevation contours for the upper aquifer for spring 1998. Along the coast, between Port Hueneme and NBVC Point Mugu, groundwater flow is toward the Pacific Ocean. Groundwater elevations are above sea level throughout the Oxnard Plain except in the southern area of NBVC Point Mugu.

The primary source of recharge for the Oxnard Plain groundwater basin is the unconfined northeastern port of the basin, known as the Oxnard Forebay or Montalvo Basin. High water levels in the Forebay exert a positive pressure on the Unconfined aquifer aquifers of the Oxnard Plain, and water flows from the recharge areas toward the coast (UWCD 1998).

In the early 1990s, seawater intrusion, the inland flow of water from the Pacific Ocean, was induced by pumping the Oxnard and Mugu aquifers. New facilities and management practices introduced in the 1980s and 1990s have significantly slowed seawater intrusion and even repelled intrusion in some areas. The recent recovery of water levels in areas of the Oxnard Plain is not an assurance that the landward migration of seawater will not recur when groundwater extraction from the basin exceeds recharge (UWCD 1996 and 1998). The upward trend in water levels in the Oxnard aquifer since the early 1990s may be a result of UWCD facilities and management as well as increased precipitation levels.

Lower Aquifer System

The Fox Canyon and Grimes Canyon aquifers comprise the lower aquifer system in the Oxnard Plain. Figure 2-10 shows the groundwater elevation surface for the lower aquifer system for spring 1998. Groundwater level contours indicate that groundwater flow between Port Hueneme and NBVC Point Mugu is generally to the southeast, parallel to the coast. A sink exists in the northeastern part of the Oxnard Plain in the Oxnard Forebay. Groundwater levels remained below sea level throughout the year in the southern and eastern quadrants of the Oxnard Plain, including NBVC Point Mugu (UWCD 1998).

Groundwater Discharge and Recharge

Data on the shallow, unconfined groundwater across the Oxnard Plain are limited, and the discharge patterns are not well known. However, based on the Phase I RI (TtEMI 2000), the upper part of the shallow, unconfined aquifer discharges primarily to surface water bodies, including the Pacific Ocean, the Santa Clara River, Revolon Slough, Calleguas Creek, Mugu Lagoon, and numerous drainage ditches. Groundwater discharge of the upper and lower aquifer systems is primarily through pumping of wells.

Recharge of the shallow, unconfined aquifer is primarily through infiltration of precipitation. The upper aquifer system is also recharged by infiltration of precipitation in the Oxnard Plain Forebay, where the clay cap separating the unconfined aquifer from the upper aquifer system is absent. The upper aquifer system is also artificially recharged by diverting water from the Santa

Clara River to the Saticoy and El Rio spreading grounds located in the Oxnard Plain Forebay. This artificial recharge probably explains the higher groundwater levels in the area (Figure 2-9).

Hydraulic Relationship between the Aquifers

The unconfined aquifer and the aquifers of the upper and lower aquifer systems are separated by aquitards that are leaky (Page 1963). However, groundwater flow between the aquifers is probably minimal. The layering of fine-grained, relatively impermeable sediments with the coarser-grained, permeable sediments restricts vertical flow within the aquifer system.

Originally, the groundwater levels in the upper aquifer system were higher than the levels in the unconfined aquifer, and there was artisan flow in the upper aquifer system wells (DWR 1965). Excessive pumping of upper-aquifer-system wells lowered the potentiometer surface such that the wells in the Oxnard aquifer no longer flowed freely. However, new facilities and management practices introduced in the 1980s and 1990s have restored artesian flow conditions in lower-aquifer-system wells.

Groundwater levels rise seasonally in lower-aquifer-system wells, and water levels approach sea level in many areas. Large annual fluctuations in water levels that result from seasonal pumping stresses confirm the relatively low permeability of the lower aquifer system (UWCD 1998).

Although water levels in the upper aquifer system have declined, they are still higher than the level of the "clay cap" confining layer, and there is an upward vertical gradient between the upper aquifer system and the unconfined aquifer (Fugro-McClelland 1991)

Seawater Intrusion and Major Ion Chemistry

Pumping of the upper and lower aquifer systems reversed the historic groundwater gradient, and groundwater flowed inland from the Pacific Ocean. This inland flow produced a significant level of seawater intrusion into the aquifers. Because of groundwater management strategies as well as increased groundwater recharge, water levels have recently been recovered in the upper aquifer system. However, they remain depressed in the lower aquifer system.

A study by the County of Ventura (1990) estimated that seawater intrusion into the Oxnard aquifer extends between 2 and 4 miles inland from the coast. More recently, Stamos and others (1992) estimated that the seawater intrusion is only about 1 to 2.5 miles inland from the coast. The earlier estimates are probably inaccurate because they were based on chloride concentrations in groundwater that are now attributed to sources other than seawater (Izbicki 1991).

Seawater has intruded into the groundwater in the unconfined aquifer at NBVC Point Mugu. Total dissolved solid (TDS) concentrations in the groundwater are high, and the major anion and cation chemistry is similar to that of seawater (Hem 1992). The groundwater exhibits a sodium-chloride type chemistry characteristic of seawater intrusion followed by cation exchange (calcium replacing sodium in solution). Ninety percent (38 of 42) of the wells in the unconfined aquifer contained TDS concentrations above 3,000 milligrams per liter (mg/L).

Seasonal variations in rainfall and the rate of freshwater recharge to the unconfined aquifer account for the seasonal fluctuations in TDS levels. In addition, tidal fluctuations may also temporarily alter TDS levels in wells that are subject to tidal influence.

Persistently high TDS concentrations in the unconfined aquifer and the underlying Oxnard aquifer are probably caused by an intruding seawater front in the unconfined and the Oxnard aquifers. Because of the widespread occurrence of high TDS concentrations, mass balance considerations rule out point source contamination as a major contributor to the TDS levels.

Because of high TDS concentrations, the unconfined aquifer is not considered a source of drinking water. That is, it does not have the beneficial use of municipal water supply. This determination is consistent with Policy 88-62, Water Quality Control Plan, Los Angeles Region (RWQCB 1994). Policy 88-62 excludes groundwater with TDS concentrations greater than 3,000 mg/L from consideration as suitable or potentially suitable for municipal or domestic water supply.

2.2.4.3 Surface Water Hydrology

Mugu Lagoon is the most significant water body within NBVC Point Mugu. The current lagoon hydrology is a function of existing freshwater inputs to the lagoon, the influence of the tides on flushing of lagoon waters, and physical modifications to surface water flow that were made within the lagoon. The lagoon itself is divided into three areas, the western arm, the eastern arm, and the central basin. Each of these areas responds in a different manner to water circulation and sedimentation.

Mugu Lagoon is connected to the Pacific Ocean through an opening in the barrier beach. The maximum tidal range measured within the lagoon is about 6 feet. The tidal range in the central basin is greatest because the central basin is directly connected to the ocean. The western and eastern arms have smaller tidal ranges because of their limited inlets.

Mugu Lagoon is relatively shallow. Depths are generally less than 10 feet at high tide. Circulation patterns within the lagoon are characterized by low mixing and flushing rates in the western arm of the lagoon and moderate to fast mixing and flushing rates in the eastern arm and central basin.

The tidal prism, the volume of water moved in an out of the lagoon, is large in comparison to the volume of water retained in the lagoon during low tide. As a result, the lagoon is a marine-dominated system.

Tidal action flushes water and sediment into and out of Mugu Lagoon. The degree of flushing varies considerably with the lunar tidal cycle and storm surges. Predominant southeast-flowing longshore currents ensure that very little of the water and material leaving the lagoon during ebb tides re-enter the lagoon on the following flood tides (Onuf 1987). The relatively large exchange of water between the lagoon and the ocean that results from tidal action creates rapid currents at the narrow opening between the lagoon and ocean. Water velocities have been measured at about 8.8 feet per second (ft/sec) at the opening (Onuf 1987).

The inlet from the Pacific Ocean to the lagoon migrates seasonally from east to west, depending on the local wave environment and flow rates in Revolon Slough and Calleguas Creek. Historically, under low flow conditions, the inlet migrated eastward along the coast from a position directly opposite the mouth of Calleguas Creek. The migration was caused primarily by longshore transport of beach sands. The original position of the mouth reestablished itself because of periodic floods and runoff from Calleguas Creek (Warme 1971). The periodic migration of the mouth maintained flushing in the eastern arm of the lagoon and ensured the presence of sandy substratum. Presently, however, increased flows through Calleguas Creek have reduced the ability of longshore currents to cause mouth migration. Thus, ocean water flushing has been reduced, and fine sediments have accumulated in the eastern arm.

The central basin of the lagoon is greatly affected by the surface water and sediment input from Calleguas Creek, Revolon Slough, and ODD No. 2 (Figure 2-4). The central basin experiences larger inputs of sediment during winter months that alter the lagoon's bottom configuration and circulation patterns.

The western arm of that lagoon receives most of the surface runoff from NBVC Point Mugu. The primary surface water input to the western arm is ODD No. 3 (Figure 2-4). This ditch transports agricultural and storm runoff from off-base sources. Sedimentation is lower in the western arm of the lagoon because of the gradual slope and slow currents in the drainage ditches that empty into the western arm. The western arm's connection to the central basin, and ultimately to the ocean, is through two culverts under Laguna Road. These culverts restrict flow under Laguna Road. They limit the hydrologic flushing rate of the western arm and the exchange of sediment with the central basin. (Steffen 1982).

The eastern arm of the lagoon receives limited freshwater input from the adjoining Laguna Peak and Point Mugu State Park to the north. Runoff from these areas flows through a series of culverts south of Highway 1. In addition, drainage from the firing range at the easternmost point in NBVC Point Mugu flows into the eastern end of this arm.

The eastern arm is connected to the central basin through tidal channels and flats that are constantly changing with the tides, storm flows, and inlet location. During floods, especially those associated with high tides, sediment-laden waters that cover the marshes on the eastern side of the lagoon are slowed by marsh vegetation. They deposit their sediments on the marsh surface and in the lagoon.

Perennial freshwater streams in the Oxnard Plain consist of Calleguas Creek and its tributaries, Revolon Slough, and Conejo Creek, located in the upper reaches of the watershed. These streams drain an area of about 325 square miles, including mountainous areas and level floodplains in the southern part of the Oxnard Plain (Steffen 1982). Flows in these streams ultimately discharge to Mugu Lagoon and serve as the primary source of freshwater input to the lagoon. The surface soils in the Oxnard Plain are primarily alluvial. They are easily erodible by surface water flows (Steffen 1982).

Freshwater inputs to Calleguas Creek come from three sources: National Pollutant Discharge Elimination System (NPDES)-permitted discharges; storm water runoff; and agricultural irrigation return. Inputs from the 20 NPDES-permitted discharges total about 31.7 million gallons per day (mgd) or 49.2 cubic feet per second (cfs). Most of this water percolates into the sediments of the creek beds before reaching Mugu Lagoon (Birosik 1993).

Because of the arid conditions and changed land use patterns in the region, the flow in Calleguas Creek is highly responsive to rainfall. Agriculture is the primary land use in the watershed. However, urbanization has increased rapidly in the past 15 years, especially in the valley and hillslope areas (U.S. Army Corps of Engineers [COE] 1992). Urbanization has resulted in increased runoff due to reduced areas available for infiltration.

Flows in Calleguas Creek also vary depending on recent hydrologic conditions. Between 1969 and 1983, flows recorded at gauging stations about 6.7 miles upstream from Mugu Lagoon ranged from no flow to a maximum of 25,900 cfs. During this period, the average flow past these stations was 41.2 cfs (Bader 1993). However, storms resulted in rapid increases in stream flow. Peak flows in Calleguas Creek were estimated for various storm intensities. In a 2-year storm, maximal flow was estimated at 2,500 cfs. A 10-year flood results in a flow of 11,810 cfs into Mugu Lagoon (Simons, Li, and Associates 1989).

Under normal conditions, most of the flow in the Calleguas Creek drainage area comes from agricultural irrigation return. Revolon Slough, which receives runoff from 38,200 acres of agricultural land (Steffen 1982), joins Calleguas Creek just within the naval base boundary, about 1.5 miles from Mugu Lagoon. Normal flow conditions in Revolon Slough and Calleguas Creek near Mugu Lagoon have not been determined.

Local freshwater flows into Mugu Lagoon from ODD No. 2, which joins Calleguas Creek on the naval base, and from ODD No. 3, which drains into the western arm of the lagoon (Figure 2-4). These ditches drain nearby agricultural land and parts of the naval base. Because they are subject to tidal influences, a series of tide gates are installed in both ditches to control flooding of the ditches and upstream farmland.

Low elevations and mild slopes characterize most of the naval base. Thus, surface water flow velocities are very slow. The surface runoff of the naval base drains into a network of ditches and culverts that ultimately drain into Mugu Lagoon or Calleguas Creek. Constrictions due to roads and other structures impede flow and tidal flushing. A small area parallel to the ocean shoreline in the southern part of the naval base drains directly into the Pacific Ocean. Much of the area surrounding the lagoon and extending west from the lagoon's western limit is tidally inundated (SCS and Landau Associates 1985). Large duck ponds are located north of the western part of the naval base.

The area of tidal influence at NBVC Point Mugu extends along Mugu Lagoon, the ocean and the surface water bodies and rivers that are in contact with or near the ocean (Figure 2-11).

2.2.5 Surrounding Land Use and Populations

The land surrounding NBVC Point Mugu is used for various agricultural, recreational, and industrial purposes, as shown in Figure 2-12. The foothills of the Santa Monica Mountains border NBVC Point Mugu to the east. They are designated as open lands used for grazing, agricultural, and recreational purposes Point Mugu State Park is also located to the east of the naval base. Point Mugu State Park, Mugu Lagoon, and the privately owned foothills are all part of the Santa Monica Mountains National Recreation Area (Fugro-McClelland 1991).

Immediately north and northwest of NBVC Point Mugu are two duck clubs: the Point Mugu Game Reserve; and the Ventura County Game Reserve These clubs provide up to 620 acres of freshwater pond habitat for migratory waterfowl, shorebirds, and nongame species. Farther to the north and northwest is a wide expanse of agricultural land. As shown on Figure 2-12, very little residential and industrial development is currently present in the immediate area of NBVC Point Mugu.

2.2.6 Ecological Characteristics

The ecosystem at NBVC Point Mugu consists primarily of the open estuarine waters of the lagoon and the coastal tidal marsh. As a result of the development of southern California, such estuaries and tidal marshes are rare.

Mugu Lagoon is large; it is surrounded by marsh and has been protected from human development because it is confined within the naval base. Mugu Lagoon supports an abundance of wildlife, including many state and federal protected species. It is a valuable natural resource (Onuf 1987).

The following sections describe habitat types and typical species, special status species, linkage among habitats, and seasonal use of habitats at NBVC Point Mugu and the surrounding area.

2.2.6.1 Habitat Types and Typical Species

Habitat types at NBVC Point Mugu consist of tidal and nontidal or upland areas. The tidally influenced areas comprise about one-half of NBVC Point Mugu and penetrate the developed part of the naval base. They include open water, tidal marsh, and intertidal mudflat habitat. Upland areas consist primarily of nonnative grassland maintained by naval base personnel, grasslands, shrublands, coastal dunes, and fresh- to brackish- to saline-water marshes. In addition, adjacent to the naval base are privately owned and managed duck ponds totaling more than 600 acres.

The four dominant habitats at NBVC Point Mugu are open water, tidal marsh, intertidal mudflat, and uplands. Table 2-3 shows the types of habitats present on the IRP sites. Food webs for these habitats are illustrated in Figures 2-13 through 2-16. The following paragraphs discuss the four dominant habitat types at NBVC Point Mugu.

Open Water. About one-fifth (300 acres) of the Mugu Lagoon system is permanently inundated open-water habitat. Submerged habitat in the lagoon system includes subtidal sediments below mean low water (Onuf 1987).

The open waters of Mugu Lagoon are strongly influenced by the lagoon's connection with the Pacific Ocean. Daily tidal action introduces a substantial volume of ocean water carrying suspended organisms and fish into the lagoon. Drainage ditches and creeks on the naval base bring fresh water into the lagoon, thereby affecting the salinity, turbidity, and nutrient levels of the water column. The lagoon is a spawning and feeding area for several species of fish, including topsmelt (*Atherinops affinis*) and staghorn sculpin (*Leptocottus armatus*) (Onuf 1987).

The open-water habitat within the lagoon is underlain by sediments of varying composition. The sediments of the central basin and lower portion of the eastern basin of the lagoon are composed mostly of sand. Fine silts and clays are deposited in the arms of the lagoon. The benthic community is generally characterized by organisms adapted to soft sediments, benthic invertebrates that burrow into sediment surfaces, and a paucity or absence of vascular plants.

Free-floating phytoplankton comprise most of the primary production, or plant growth, in the open-water habitat. However, because the waters immediately offshore are generally turbid and nutrient-poor, ocean phytoplankton introduced by tidal action contribute little to the overall primary production of the lagoon (Onuf 1987). Instead, the water column is dominated by benthic diatoms, dinoflagellates, and filamentous blue-green algae (Zedler 1982). Figure 2-13 illustrates the open-water food web in Mugu Lagoon.

Zooplankton are the most significant primary consumers of phytoplankton in Mugu Lagoon. Several zooplankton species found in the lagoon are copepods, cladocerans, ostracods, and arrow worms (MacDonald 1976). Topsmelt use the lagoon for spawning, so both adults and young are frequently found in the lagoon. Topsmelt feed primarily on diatoms and algae. However, they also consume small crustaceans, insects, and some benthic invertebrates (Onuf 1987). Another major group of primary consumers is the filter feeders, including clams and snails, which feed mainly on planktonic organisms.

The secondary consumers consist primarily of avian predators, such as the California brown pelican (*Pelacanus occidentalis californicus*) and the California least tern (*Sterna antillarum browníi*). These bird species prey on fish, such as topsmelt. Other secondary consumers include fish, such as California killifish (*Fundulus parvipinnis*), which feed on small crustaceans and gastropod mollusks, and California halibut (*Paralichthys californicus*), which feed on small fish and crustaceans (Onuf 1987).

Tidal Marsh

Intermittently flooded tidal marsh is widespread throughout NBVC Point Mugu. It totals about 1,011 acres. Tidal marsh is found between mean high water and extreme high water. It is characterized by vascular plants, such as cordgrass (*Spartina foliosa*). The eastern arm of Mugu Lagoon contains tidal marsh directly north of the ocean inlet and north and east of the central basin. The western arm of the lagoon has tidal marsh on both its northern and southern edges.

Pickleweed (*Salicornia* spp.), a low-growing succulent halophyte, is found in the frequently inundated, low elevations of the marsh. It also occurs in the high marsh with other vascular plants, such as grasses, rushes, and herbaceous plants. The plant species composition of the less-frequently inundated higher elevations reflects significant changes in salinity and shorter periods of inundation. The soils are sandy and relatively inorganic, and the dominant plant species are low-growing halophytes. The transition zone, where developed areas and roads border the marsh, is dominated by low-growing shrub species.

Salt panne habitat is found at the extreme upper edges of the tidal marsh and is inundated by only the highest tides and storm events. Water deposited in salt panne habitat is removed by evaporation, leaving barren, scalded areas. Only plants and animals tolerant of hypersaline environments can exist in this habitat. Salt panne habitat exists east of the sewage treatment ponds at NBVC Point Mugu.

Figure 2-14 illustrates the tidal marsh food web at NBVC Point Mugu. Algae are important primary producers of the tidal marsh. Algal mats in the tidal marsh consist of green algae, blue-green algae, and numerous diatom species. Algal mats tend to occur in areas with sparse vascular plant cover.

Primary consumers of the tidal marsh are benthic epifaunal invertebrates, such as the California hornsnail (*Cerithidea californica*), which is abundant in the upper reaches of the tidal channels entering the marsh. California hornsnails are found primarily in tidal pools. They forage on benthic diatoms and detritus. Another dominant species and primary consumer in the tidal marsh is the California melampus snail (*Melampus olivasceous*), which feeds on marsh algal mats (Zedler 1982). Striped shore crabs (*Pachygrapsus crassipes*) and yellow shore crabs (*Hemigrapsus oregonensis*) are other common benthic epifaunal species that feed on algae and diatoms.

There is little direct consumption of the vascular plants of the tidal marsh at Mugu Lagoon. Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) may feed on the succulent tips of pickleweed, but only when insects are rare. Small mammals, such as the California vole (*Microtus californicus*), may also forage on marsh vegetation.

Secondary consumers of the tidal marsh are fish and birds. Topsmelt, California killifish, staghorn sculpin, arrow gobies, and longjaw mudsuckers (*Gillichthys mirabilis*), fish species that are common in Mugu Lagoon, often move into tidal marsh areas. The topsmelt and California killifish move with the tide in order to feed. The staghorn sculpin and longjaw mudsuckers often remain in the tidal marsh and retreat into burrows and depressions when the tide retreats.

Herons, egrets, and other marsh birds are abundant along tidal creeks in the marsh. The snowy egret (*Egretta thula*) and the great egret (*Casmerodius albus*) are seasonal visitors from September through April. The great blue heron (*Ardea herodias*) is a permanent resident of the Mugu Lagoon area. These herons and egrets forage for fish, small crustaceans, and other invertebrates in the marsh and in other habitats at NBVC Point Mugu.

The federally listed light-footed clapper rail (*Rallus longirostris levipes*) nests in stands of cordgrass in the tidal marsh of Mugu Lagoon (Onuf 1987). The marsh is also an important foraging area for the rail, which eats snails, crabs, and fish. Other marsh birds that inhabit NBVC Point Mugu include willets (*Catoptrophorus semipalmatus*), godwits (*Limosa fedoa*), long- and short-billed dowitchers (*Limnodromus scolapaceas* and *L. griseus*, respectively), stilts, and avocets (*Recurvirostra americana*).

Intertidal Mudflats

Intertidal mudflats, which occur between mean lower low water and mean high water, cover about 123 acres of Mugu Lagoon. Tidal flats of bare mud adjacent to subtidal channels occur in the central basin and the eastern and western arms of the lagoon. Tidal flushing and sediment deposition in the lagoon have resulted in sandy tidal flats in the eastern arm and silty clay surface sediments in the western arm. In recent years, mudflats of the central basin have increased because of sedimentation of the basin.

Figure 2-15 illustrates the intertidal mudflat food web at NBVC Point Mugu. Green algae, benthic diatoms, and blue-green algae dominate the mud surface. Infaunal bivalve mollusks and crabs are common primary consumers on the mudflat. The California hornsnail is a dominant epifaunal grazer of the higher mudflat. It feeds primarily on fine organic detritus and on algae on the mud surface.

Secondary consumers are fish and shorebirds. The fish move into the mudflat habitat on incoming tides. Species that are common to the mudflats include topsmelt, arrow gobies, shiner serfperch, and California killifish.

Numerous species of surface-feeding and probing shorebirds forage over the mudflats for sediment-dwelling invertebrates. Most shorebirds are seasonal visitors, typically during the winter months. Common shorebird species at Mugu Lagoon include willets, long- and short-billed dowitchers, and western sandpipers (*Calidris mauri*). Prey items include marine worms, small crustaceans, and mollusks. The state- and federally-listed endangered American peregrine falcon (*Falco peregrinus anatum*) is also a seasonal visitor to NBVC Point Mugu. It may be found on the mudflats as well as in other habitats. It preys on small birds and waterfowl.

Uplands

The most prevalent upland habitat at NBVC Point Mugu is nonnative grassland composed primarily of ruderal vegetation. This grassland habitat occurs to the north and west of the central basin in the vicinity of naval base infrastructure such as runways, roads, buildings, and paved areas. Other upland areas include coastal dune habitat

Figure 2-16 illustrates the upland food web at NBVC Point Mugu. The uplands support cultivated grasses, ornamental plants, and remnant native vegetation. Many passerine birds, small mammals, and raptors use these grasslands. Small mammals include various species of mice, ground squirrels, raccoons, and rabbits. These animals are subject to predation by foxes, coyotes, and raptors.

Species of raptors recorded on NBVC Point Mugu include American kestrel, American peregrine falcon, red-tailed hawk, red-shouldered hawk, northern harrier, osprey, black-shouldered kite, and burrowing owl (PRC 1993). All raptor species are nonbreeding migrants or winter visitors. They feed on mammals, insects, and smaller birds.

Other uplands at NBVC Point Mugu include a 290-acre coastal dune habitat that forms the barrier between the sand beach to the south and salt marshes to the north along the eastern and western arms of the lagoon.

2.2.6.2 Special Status Species

NBVC Point Mugu supports a variety of threatened, endangered, or other special status categories of plant and animal species. A complete list of special status species expected at NBVC Point Mugu is presented in Table 2-4.

Populations of the state- and federally-endangered salt marsh bird's beak (*Cordylanthus maritimus*) occur in the high marsh on the southwestern part of the naval base (Onuf 1987). This plant is hemiparasitic. It is capable of completing its life cycle without host plants, or it can be parasitic on the roots of other plants. It has a high tolerance for saline conditions.

Belding's savannah sparrow is listed as endangered by the State of California. It is a local, year-round resident at NBVC Point Mugu (Onuf 1987). The sparrow forages on a variety of insects, seeds, and small invertebrates. It has been observed feeding in upland, dune, beach, and exposed mudflat habitats (Onuf 1987; Massey 1979).

The state and federally listed light-footed clapper rail breeds on the marshes surrounding Mugu Lagoon (Onuf 1987). Primary nesting habitat occurs in the lower salt marsh. The California least tern (*Sterna antillarum browni*), another state- and federally-listed endangered species, is also reported to occur at NBVC Point Mugu.

The American peregrine falcon is currently listed as endangered by both the U.S. Fish and Wildlife Service (FWS) and the State of California. Peregrines are seasonal visitors at NBVC Point Mugu and are found in all habitat types that provide foraging habitat for its prey. Peregrines feed mostly on small birds, shorebirds, and waterfowl.

The western snowy plover (*Charadrius alexandrinus nivosus*) is a California species of special concern. It was federally listed as threatened in 1993 (PRC 1993). The plover forages for insects and other small invertebrates in lagoon mudflats.

The harbor seal (*Phoca vitulina*), a species protected under the Marine Mammal Protection Act, is a year-round visitor at NBVC Point Mugu. It hauls out on beaches and sandbars near the mouth of the lagoon (Onuf 1987).

2.2.6.3 Linkage Among Habitats

The movement of predators and prey between habitats is considered in evaluating ecological exposure. Omnivorous birds, such as Belding's savannah sparrow, and omnivorous mammals, such as deer mice, house mice, and red fox, may feed in both upland and marsh habitats. Insectivorous birds and mammals move between habitats based on seasonal and tidal cycles.

Predators forage in both marsh and upland habitats. Peregrine falcons consume shorebirds, waterfowl, and passerines (Bell and others 1994). Black-shouldered kites feed on insects and rodents in marsh areas. Northern harriers may feed on western harvest mice in the marsh, and prey on upland rodents, birds, and lizards.

2.2.6.4 Seasonal Use of Habitats

Some ecological receptors are more prevalent at NBVC Point Mugu during certain times of the year. For example, seasonality in habitat use is displayed by fishes during the summer and by surface feeding and probing shorebirds foraging on intertidal mudflats and shallow open waters during winter months (Onuf 1987). Shorebirds respond to prey availability over their migratory range, while fish may respond to temperature differences between the lagoon and near-shore waters. Increased watershed discharges, which reduce estuarine salinity during the winter season, may also influence prey or predator abundance.

Less frequent tidal inundation of the high marsh may affect the seasonality of plant growth and associated animal habitat use. Precipitation and high tides during storm periods are generally greater during the winter months. This precipitation may initiate earlier and more pronounced plant growth (Onuf 1987). Plant and animal species that prefer lower salinities may also increase use from spring through early summer, prior to late summer, and during fall periods of drier soils and higher salinity. For example, the salt pannes are used by waterfowl in winter and by small mammals and insects in the summer and fall (Zedler and Norby 1986).

2.2.7 Cultural Resources

Only one Chumash Indian archaeological site is known to occur within the boundaries of NBVC Point Mugu. It is currently being assessed for the National Register of Historic Places. In addition, about 12 historic sites have been identified at the naval base. They include the historic Mugu Fish Camp, several historic ranches, and several shipwrecks.

2.3 IRP SITE DESCRIPTIONS

This section provides a brief description of IRP Sites 2, 4, 8, and 9 at NBVC Point Mugu. Figure 2-17 shows the location of these sites within the naval base.

2.3.1 IRP Site 2 – Old Shops Area

IRP Site 2, the old shops area, is a 30-acre area that is actively operated as a public works vehicle maintenance area. The site is located at the southern end of South Mugu Road, which transects the entire site (Figure 2-18). The site is also accessible from the north by Dump Road. The site is about 500 feet east of Laguna Road; to the west of Laguna Road is Drainage Ditch No. 7, which leads directly to Mugu Lagoon. The southern and eastern portions of the site are directly adjacent to Mugu Lagoon. The surface of the site consists of soil and small grassy areas, paved roads, and gravel parking areas. Numerous buildings are present within the site boundaries.

IRP Site 2 consists of developed areas, and of nonnative grassland. Intertidal mudflat and tidal marsh habitats border the site in Mugu Lagoon. Much of the surface of the site is either paved or exposed dirt, with a few vegetated areas consisting of nonnative grassland/scrub habitat. These areas could support small mammal and passerine bird communities. Mammals present include several species of mice, rabbit, fox, and coyote. Intertidal mudflat borders the site to the south and east with some tidal marsh habitat present at higher elevations.

2.3.1.1 History of Use

Disposal activities took place at IRP Site 2 from 1942 to 1980. During that period, wastes from site shops were spread on the surface for disposal. The wastes included battery acid, solvents, thinners, paint wastes, pesticide rinsate, and waste oil. The origins of the wastes, waste types, estimated volumes, and the periods during which disposal reportedly occurred are presented in Table 2-5 (PRC and JMM 1993). A summary of IRP Site 2 disposal practices and source/disposal areas are listed below.

- Battery acid was poured on the ground in the area around Building 4-30 and on the northwest side of Building 402.
- In the 1950s and 1960s, waste oil was collected from the generator and vehicle maintenance shops and used for dust control several times each year.

- Rinsate from pesticide mixing and cleanup operations was disposed of around Building 4-6.

- From the 1940s through the early 1960s, waste paints, solvents, and thinners were generated at the paint shops and disposed of at areas around Buildings 4-2, 4-3, 4-7, 4-8, 4-10, 4-11, and 4-25.

During an industrial waste study (Brown and Caldwell 1978), high lead levels were identified in the vicinity of Building 402. The lead-contaminated soil was reportedly removed and disposed of off site. Both the volume of soil removed and disposed of and the period of disposal are unknown.

2.3.1.2 Previous Investigations

In 1985, SCS and Landau Associates conducted an initial assessment study (IAS) at IRP Site 2. Historical information regarding IRP Site 2 and the types of wastes disposed of at the site were summarized in the IAS report (SCS and Landau Associates 1985).

A site inspection (SI) was conducted at IRP Site 2 (Fugro-McClelland 1991) to determine whether hazardous materials were present and whether shallow groundwater, possibly impacted by IRP Site 2, was affecting Mugu Lagoon. Soil gas samples were collected from 35 sampling points at 31 locations at depths ranging from 0.5 feet to 4.5 feet bgs. Thirty-three soil boring samples were collected from 12 boring locations at depths of 0.5 feet to 5.9 feet bgs, and 3 monitoring wells (MW2-1, MW2-2, and MW2-3) were sampled. Sample results were used to define the type and extent of contamination. Soil contaminants identified during the SI included volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides, and inorganic chemicals. Inorganic chemicals also were identified as potential groundwater contaminants. Polychlorinated biphenyls (PCB) were not identified in soil or groundwater samples (Fugro-McClelland 1991; TtEMI 2000).

During the Phase I RI field activities in 1994, soil boring samples were collected to define the vertical and lateral extent of contamination at Site 2 and to characterize background soil concentrations (Figure 2-18). Fifty-one surface and subsurface soil samples were collected at 22 soil boring locations. Two additional monitoring wells (MW2-4 and MW2-5) were installed to supplement existing wells installed during the SI. Groundwater samples were collected from the four monitoring wells at the site (MW2-1, MW2-3, MW2-4 and MW-5) over a four-quarter period in 1994 and were analyzed for in situ parameters and chemicals. Figure 2-18 shows sample and monitoring well locations. Phase I RI field activities also included a tidal influence study and ecological data collection.

The HHRA performed for IRP Site 2 during the Phase I RI included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). The HHRA determined that Aroclor 1260 was a COC in soil at Site 2. Aroclor 1260 was detected in the southeastern and southwestern portions of Site 2. No inorganic COCs were determined for Site 2 soil from the HHRA. No COCs were determined for Site 2 soil from the Phase I ecological risk assessment.

The RI for Groundwater (TtEMI 2004) did not identify any COPCs or COPECs in groundwater at IRP Site 2. Groundwater samples showed measurable detections of the inorganic contaminants cobalt, copper, lead, mercury, nickel, and zinc. However, these contaminants were measured at low concentrations and were not found on a consistent basis. No organic contaminants were found in groundwater at the site.

Detailed discussion of risk assessment results for IRP Site 2 is in Section 3.1 of the FS. The HHRA for pathways of concern were reevaluated for Site 2 using the Phase I RI soil data and this evaluation is included in Section 3.1.

2.3.1.3 Physical Characteristics

This section presents information concerning the site-specific geology, hydrogeology, and surface water hydrology at IRP Site 2.

Geology

IRP Site 2 is located adjacent to the central basin of Mugu Lagoon and near the current and historic inlet of Calleguas Creek into Mugu Lagoon. The site is located on a tidal saltwater marsh and sand bar complex that was filled prior to site operations (PRC and JMM 1993). Calleguas Creek deposits sand, silt, and clay as the water velocity of the creek slows upon entering the lagoon. Mugu Lagoon contains deposits of silt and clay.

The correlated lithology at IRP Site 2 indicates that the unconfined aquifer extends to an approximate depth of 125 feet bgs; the clay cap is present from about 125 to 145 feet bgs; the Oxnard aquifer is present from about 145 to 225 feet bgs; an aquitard is present from 225 to 270 feet bgs and as a lens from 305 to 345 feet bgs; the Mugu aquifer is present from about 270 to 305 feet and 345 to 380 feet bgs; and an aquitard is present from 380 to 415 feet bgs. The top of the Fox Canyon and Grimes Canyon aquifer system is encountered at about 415 feet bgs. The total depth of the Fox Canyon and Grimes Canyon aquifer system was not determined from these borings.

The lithology observed at IRP Site 2 consists mainly of lowland fill materials overlying an interbedded sand and silt unit. A discontinuous clay unit separates the fill and sand units at the north and southeast portions of the site. Figures 2-19, 2-20, and 2-21 depict the shallow lithology for IRP Site 2 and represent the synthesis of information from the borings depicted and the borings not shown on the figures.

The fill material includes lowland fill that consists of sand, silt, and gravel, scraped from other areas of the base. Some solid waste fill (wood debris) was encountered in the northwestern portions of the site at boring B2-19. Lowland filling occurred during construction of the base to fill in marshy and tidal areas. Lowland fill is present across the site and includes sand, silt, and gravel. Lowland fill was differentiated from native soil by the presence of angular gravel. Cross section AB-AB' (Figure 2-19) correlates lowland fill from IRP Site 1, in the north, into IRP Site 2.

A clay unit directly underlies the lowland fill in the northern and southeastern portions of IRP Site 2. The clay is discontinuous and is in lateral contact with the underlying sand unit. The unit ranges from 1 foot to 3.5 feet thick and consists primarily of clay, clayey sand, and sandy clay (Figures 2-19 and 2-20). The clay is interpreted as representing the historic change in lithology between the tidal saltwater marsh areas and the sandbars or uplands that currently surround Mugu Lagoon and Calleguas Creek. The clay unit may be a local, discontinuous hydrogeologic barrier in the uppermost portion of the unconfined aquifer, as evidenced by the saturated soils observed during drilling above the clay unit

The sand unit was encountered across IRP Site 2 during the boring activities for both the SI and Phase I RI (TtEMI 2000). The sand unit was found to be laterally continuous and was in direct contact with the lowland fill throughout the site, except in the north and southeast portions where it is in direct contact with the discontinuous clay unit. The total depth of the sand unit was not determined during SI or Phase I RI activities due to the shallowness of the completed borings.

Hydrogeology

The shallow groundwater at IRP Site 2 is partially confined. Figure 2-22, 2-23, and 2-24 presents the groundwater elevation contour maps for three quarters during the RI for Groundwater (TtEMI 2004). Groundwater flows southwesterly from the north end of Site 1 and discharges to the southeast along the edge of Sites 1 and 2 into the mudflats bordering Mugu Lagoon. Along the northern portion of Site 1, groundwater flows to the southwest toward tidal ponds and the Laguna Road drainage ditch (No. 7) Thus, a north-south groundwater divide extends through Site 1 and then becomes oriented east-west through IRP Site 2. Groundwater flows radically from IRP Site 2 toward two tidal ponds and the Laguna Road drainage ditch; west from IRP Site 2 into the Laguna Road drainage ditch; and south and southwest into Mugu Lagoon. The depth to groundwater in the uppermost water-bearing zone at IRP Site 2 varies between about 1.5 and 4.5 feet bgs depending on the location, seasonal variations, and tidal fluctuations.

As discussed in the Phase I RI, the groundwater at NBVC Point Mugu exhibits a sodium-chloride type chemistry that is characteristic of seawater intrusion (Hem 1992). The average TDS concentration at Site 2 is 8,630 mg/L. The site TDS concentrations exceed the 3,000 mg/L limit for groundwater set forth in Policy 88-63, Water Quality Control Plan, Los Angeles Region (RWQCB 1994). Therefore, the shallow unconfined aquifer is unsuitable as a source of drinking water and is not feasible to use the aquifer for municipal water supply, thereby justifying that the aquifer has no beneficial use. This determination is consistent with Policy 88-63, Water Quality Control Plan, Los Angeles Region (RWQCB 1994).

Surface Water Hydrology

IRP Site 2 lies within drainage area 13, a 155-acre area on the west side of the central basin of the lagoon, and drainage area 12, a 168-acre area on the east and west side of Laguna Road (PRC and JMM 1993). Surface water runoff from the south and east portions of the site is directed to four outfalls that discharge to the lagoon mudflats. Runoff from the north and west portions of the site flow to marsh areas between Dump Road and South Mugu Road. Surface water in the marsh is connected by culverts to water within Drainage Ditch No 7 and may be affected by high tides. Based on field observations, topographic maps, and aerial photographs of the site vicinity, no obvious erosional channels on the site surface lead to the lagoon mudflats.

2.3.2 IRP Site 4 – Public Works Storage Yard

IRP Site 4, the public works storage yard, was a 12-acre area located about 600 feet west of Laguna Road and 300 feet north of Mugu Lagoon (Figure 2-25). The site was an active storage yard where vehicles, maintenance equipment, and miscellaneous maintenance parts were stored. Several buildings were present on the southwestern portion of the site. Site 4 was unpaved, except for Storage Road, which ran through the center of the site (Figure 2-25). An unlined drainage ditch (No. 6) that leads directly into Mugu Lagoon forms the western border of the site. A small, unlined ditch ran through the middle of the site into a salt marsh east of the site and then into Drainage Ditch No. 7, which leads to Mugu Lagoon. The small ditch generally contained water only after rain events. Both drainage ditches (Nos. 6 and 7) are tidally influenced, and the area immediately south of IRP Site 4 is inundated by high (spring) tides about twice a year.

Removal of contaminated soils and restoration of the area as wetland and sandy bird habitat occurred in 1997. The existing buildings, roads, and utilities were removed, as well as the site monitoring wells. Currently the site consists of two sand islands and surrounding wetlands.

2.3.2.1 History of Use

Between 1966 and 1970, transformers were serviced and maintained in the eastern portion of IRP Site 4 (Figure 2-25). Some of the transformers that were serviced or stored reportedly contained PCBs. An estimated 20 to 40 gallons of PCB or PCB-contaminated transformer fluid leaked from the transformers onto the unpaved ground. On average, five to six pole-mounted can-type transformers were serviced each year over the 4-year period (PRC and JMM 1993). Transformers as well as waste chemical and oil drums were stored in the northern portion of IRP Site 4 (Figure 2-25), although neither the volume nor content of these drums has been identified. Some drums, however, reportedly contained the following (PRC and JMM 1993):

- Unspecified solvents
- Carbon tetrachloride
- Trichloroethene
- Waste oil
- Stoddard solvents

- Paints containing lead
- Paint stripper sludge containing methylene chloride
- Phenols

During an August 1994 site visit, sandblasting was being conducted to the east of Building 617 (Figure 2-25). Sandblasting wastes in the form of a black grit were not contained, and have been spread by wind and carried by vehicle tires and storm water beyond the sandblasting area.

Disposal areas at IRP Site 4 are described below, with the areas noted shown in Figure 2-26.

- The transformer maintenance and storage area (about ¾ acre on the eastern portion of the site) was used for storage and service of transformers that reportedly contained PCBs. Spill reports estimate that 20 to 40 gallons of PCB or PCB-contaminated transformer fluid leaked from the transformers onto unpaved ground.

- The waste chemical drum storage area (about 3 acres on the northern and central portion of the site) was used for storage of transformers and waste chemical and oil drums.

- The sandblasting area (visible sandblasting grit covered about ¼ acre east of Building 617) was observed in operation during a site visit in August 1994. Sandblasting waste was not contained and was spread to other parts of the site by wind, vehicle tires, and storm water.

2.3.2.2 Previous Investigations

In 1985, SCS and Landau Associates conducted an IAS at IRP Site 4. Historical information regarding IRP Site 4 and the types of wastes disposed of at the site were summarized in the IAS report (SCS and Landau Associates 1985)

An SI was performed in 1989 at IRP Site 4 (Fugro-McClelland 1991) to assess whether hazardous materials were present and to determine whether shallow groundwater, potentially impacted by IRP Site 4, was affecting surface water bodies near the site. Soil borings and monitoring wells were used to define the type and extent of contamination. Eighteen composite soil samples were collected from 10 boreholes within Site 4 during the 1989 SI. Four surface water samples were collected from the unlined drainage ditch (No. 6) just west of the site. VOCs, SVOCs, Aroclor 1260, chromium, and lead were detected in the soil boring samples. Chromium and lead were also detected in the sediment samples, along with dichlorodiphenyltrichloroethane (DDT) and its degradation products. The surface water samples appeared to be free of contamination, with the exception of chromium. Results of the SI are summarized in the Phase I RI (TtEMI 2000).

The HHRA performed for IRP Site 4 during the Phase I RI included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). Preliminary COPCs identified for soil included VOCs, SVOCs, pesticides/PCBs, and inorganics, including heavy metals. The COPCs evaluated quantitatively in the HHRA following the COPC identification process were Aroclor-1254, Aroclor-1260, and lead. The HHRA determined that pathway risks for these chemicals did not exceed target risk or hazard levels, therefore no COCs were identified.

In 1994, the Phase I RI field investigation activities included the collection of surface soil samples from 66 locations throughout Site 4 (Figure 2-26). These data was used to support the Phase I ecological assessment and to evaluate the potential effects of contaminants in surface water as well as soil and sediment to a depth of approximately 3 feet. Thirty composite soil samples were collected from 15 boreholes and 58 sediment samples were collected from 16 drainage ditch locations. The ecological risk assessment for the surface soil samples are presented in draft Phase I RI technical memorandum (PRC 1996). COCs evaluated in the RI technical memorandum based on human and ecological risk were SVOCs, pesticides, PCBs, and metals (PRC 1996).

A predictive risk assessment was performed in 1996 to derive ecological risk-based screening levels and to develop cleanup goals for materials to be dredged during a removal action at Site 4. These ecological-based screening levels were intended to represent concentrations of potential contaminants that may remain in the sand island construction materials and in the residual soil will be protective of ecological receptors (avians) that are likely to use the proposed wetland that was constructed as part of the removal action (OHM 1996). An exposure assessment was completed for the California clapper rail, Least Tern, Great Blue Heron, Western Sandpiper, and Perguine Falcon. The primary PCB detected at the site was Aroclor 1260. Metals that exceeded cleanup goals were arsenic, copper, and lead. Cleanup levels were established for PCBs (0.88 milligrams per kilogram [mg/kg]), arsenic (20 mg/kg), lead (64 mg/kg), and copper (182 mg/kg) (OHM 1996).

The removal action was conducted in 1997 and confirmation samples were collected to ensure that COCs were removed or minimized. Results from the confirmation sampling indicated that the removal action effectively eliminated all COCs in soils. The confirmation sampling results are summarized in the removal action documentation report (OHM 1997). Confirmation samples collected as part of the removal met the RAOs for the site (OHM 1997). Upon completion of the removal action, Site 4 was restored as a wetland habitat.

During the Phase I field activities in 1994, five groundwater-monitoring wells were installed at IRP Site 4 (MW4-1, MW4-2, MW4-3, MW4-4, and MW4-5). Four quarters of groundwater samples were collected from these wells in 1994 to evaluate groundwater flow direction and the attenuation of ecological COPCs in groundwater at the site (TtEMI 2000). COPECs for groundwater at IRP Site 4 were identified in the Phase I RI because the potential exists for a complete pathway to surface-water ecological receptors. Inorganic contaminants detected in groundwater at IRP Site 4 included copper, nickel, lead, and silver. Each metal occurred in groundwater samples at a frequency greater than 5 percent, and also exceeded either a chronic or an acute ambient water quality criterion. However, none of these contaminants were found to be

COCs, and no groundwater COCs were identified for IRP Site 4 in the Phase I RI (TtEMI 2000). The five Site 4 monitoring wells were abandoned during removal activities in 1997

The RI for Groundwater (TtEMI 2004) did not identify any locations at IRP Site 4 where groundwater contaminants were detected at levels above National Ambient Water Quality Criteria. The RI for Groundwater also did not identify any COPCs or COPECs for groundwater at IRP Site 4.

Section 3.2 of this FS describes the risks resulting from contaminants in soil and groundwater at IRP Site 4 and discusses the risk assessment results for the site.

2.3.2.3 Physical Characteristics

This section presents information concerning the site-specific geology, hydrogeology and surface water hydrology at IRP Site 4.

Geology

The unconfined aquifer extends to an approximate depth of 120 feet bgs; the clay cap is present from about 125 to 145 feet bgs; the Oxnard aquifer is present from about 145 to 225 feet bgs; an aquitard is present from 225 to 270 feet bgs and as a lens from 305 to 345 feet bgs; the Mugu aquifer is present from about 270 to 305 feet and 345 to 380 feet bgs; and an aquitard is present from 380 to 445 feet bgs. The top of the Fox Canyon and Grimes Canyon aquifer system is encountered at about 445 feet bgs.

Soil borings conducted during the SI and Phase I RI were advanced to a maximum depth of 13.5 feet bgs. The lithology observed at IRP Site 4 consists of fill materials overlying a semicontinuous clay unit and a sand unit with interbedded silt. A second clay unit was encountered in a single well on the east side of IRP Site 4.

The fill material included a lowland fill that consisted of readily available soil materials scraped from areas of NBVC Point Mugu. Lowland filling occurred during construction of the naval base to fill in marshy and tidal areas. The elevated site area, as compared to the surrounding tidal marsh area, indicated that lowland fill was present across IRP Site 4. Lowland fill was differentiated from native soil by the presence of angular gravel and wood, metal, and brick debris.

The clay unit directly underlies the lowland fill, now restored as sand islands. This unit extends beneath the islands along the northern side of the site and was encountered primarily in borings north of the east-west dirt road (the former Storage Road) across IRP Site 4 (Figure 2-27). The unit ranges from 0 to 2 feet thick and consists primarily of clay with some sand and silt. The clay unit was typically encountered at an approximate depth of 1 to 3 feet bgs. The clay is interpreted as representing the historic surface of the tidal saltwater marsh that was filled to construct IRP Site 4. The clay unit may be a local hydrogeologic barrier in the uppermost portion of the unconfined aquifer, as evidenced by the saturated soils first observed during drilling below the clay unit

The sand unit was encountered across Site 4 during the boring activities for both the SI (Fugro-McClelland 1991) and the Phase I RI (TtEMI 2000). The sand unit is laterally continuous and is in direct contact with the clay unit across the northern portion of Site 4, except at boring B4-11 where it is in contact with the fill. The sand unit was in direct contact with the lowland fill in the area south of the former Storage Road except at boring MW 4-5 where it is in direct contact with the clay unit (Figure 2-27). The total thickness of the sand unit was not determined during SI or Phase I RI activities because of the shallowness of the completed borings. The sand unit consists primarily of fine- to medium-grained sand.

The lower clay unit was encountered at about 10 feet bgs at boring MW 4-2, with a minimum thickness of 3 feet. Because relatively few borings were completed to depths greater than about 5 feet bgs, the lateral extent of the lower clay unit is not known. The lower clay unit was not encountered in borings MW 4-1 or MW 4-3, both of which were completed to the same depth as MW 4-2. The lower clay unit contained some sand and silt stringers.

Hydrogeology

Shallow groundwater at IRP Site 4 may be partially confined as evidenced by the presence of a lateral clay unit along the southern edge of the site. Figured 2-22, 2-23, and 2-24 presents the groundwater surface contour maps for three quarters of groundwater elevation measurements taken in 1994 Groundwater and surface water elevations are tidally influenced at IRP Site 4.

As discussed in the Phase I RI, the groundwater at NBVC Point Mugu exhibits a sodium-chloride type chemistry that is characteristic of seawater intrusion (Hem 1992). The average TDS concentration at IRP Site 4 is 17,500 mg/L as measured during the Phase I RI (TtEMI 2000). The site TDS concentration exceeds the 3,000 mg/L limit for groundwater set forth in Policy 88-63, Water Quality Control Plan, Los Angeles Region (RWQCB 1994), making the shallow unconfined aquifer unsuitable as a source of drinking water. It also is not feasible to use the aquifer for a municipal water supply, so the aquifer has no beneficial use.

Surface Water Hydrology

IRP Site 4 is surrounded by marshes located between two north-south trending drainage ditches (Nos. 6 and 7) on the north shore of Mugu Lagoon (Figure 2-28). The site was relatively flat with a small tidally inundated salt marsh along the northeast corner, which is connected to the lagoon by Drainage Ditch No. 7. Drainage Ditch No. 6 to the east extends from Mugu Lagoon to 2,000 feet north of the main portion of the site, which consists of the sand islands.

Surface water runoff from the site flows into small drainage ditches on and adjacent to the site, which then flows through Drainage Area 12 to Drainage Ditch No. 7 to the east. Drainage Area 12 covers about 168 acres and consists of marsh and the sand islands. Runoff in drainage area 12 flows overland into marshes and into Drainage Ditch No. 7, which empties into Mugu

Lagoon. Drainage Ditch No. 7 is tidally influenced; surface water from incoming tides flows into ditches and low-lying areas on both the west and east sides of Laguna Road.

Because of the topography before the restoration of IRP Site 4, nearly all surface water runoff flows toward Drainage Ditch No. 7 except for runoff along the bank of Drainage Ditch No. 7. Drainage Ditch No. 6 receives surface runoff from areas to the west of the site and is tidally influenced. Flow in Drainage Ditch No. 6 was formerly restricted by a flow control structure, which consists of a combination of tide heights, and three small (10-inch-diameter) metal pipe conduits near the high-water line. There are flap gates on the upper conduits on the south (lagoon) side of the structure, but none on the lower conduits. Tides were observed and currents measured at the bridge and tide gate structure in Drainage Ditch No. 6 The NBVC Point Mugu area, including Mugu Lagoon, is subject to tidal fluctuations which are characterized by two high tides and two low tides during a 24-hour period. Tidal fluctuations observed in Drainage Ditch No. 6 are also characteristic of this type of tidal cycle.

In general, the neap tide curve at IRP Site 4 more closely mimics the predicted tides for the area than does the spring tide curve. Time lags occur for all tide levels at IRP Site 4. In the spring, the lower tide water levels are considerably higher than the predicted tide levels. The higher low tides and the longer time lags experienced at IRP Site 4 during the spring tide may result from the larger water volumes that the narrow ditch, shallow tidal marsh channels, and the bridge and tide gate structure must accommodate. All of these natural and constructed features tend to restrict flow and can apparently more easily accommodate the smaller tidal prism associated with neap tides. The highest currents associated with both the spring and neap tides were observed during mid-tide. These tidal currents apparently have the greatest potential to resuspend and transport sediments in Drainage Ditch No. 6 (as well as in Drainage Ditch No. 7 and associated marshes).

2.3.3 IRP Site 8 – Runway Landfill

IRP Site 8, the runway landfill, is located north of 11th Street, immediately west of Laguna Road, at the northeast end of Runway 9-27 (Figure 2-29). The site is currently within a fenced, controlled-access area. IRP Site 8 is approximately 4 acres in area, and is vegetated with grasses. A drainage ditch formerly located within the site was moved to the north in the 1950s. A former Native American burial ground is reportedly located west of IRP Site 8, just east of Runway 9-27 (TtEMI 2000).

The habitat at IRP Site 8 is predominantly upland, with some marsh habitat to the north and east. The upland area is populated with nonindigenous grasses and small mammals, birds, and invertebrates. The marsh is populated by birds, insects, and benthic organisms.

2.3.3.1 History of Use

The runway landfill was reportedly used for trash burning and the disposal of shop and household wastes from the mid-1940s until 1952 (PRC and JMM 1993). The volume and specific type of wastes disposed at IRP Site 8 are poorly documented. However, plastic and metal debris was observed during the Phase I RI. The landfill was reportedly covered with 3 feet of soil when the landfill was abandoned (SCS and Landau Associates 1985).

2.3.3.2 Previous Investigations

An IAS (SCS and Landau Associates 1985) concluded that the spread of contaminants from the source area at IRP Site 8 was not likely, and therefore no further study of the site was necessary. However, the NBVC Point Mugu technical review committee recommended additional sampling. An SI was conducted to provide further data (Fugro-McClelland 1991). The SI included a geophysical survey to better determine the boundaries of the landfill. Soil samples were collected during the installation of four shallow monitoring wells. The soil samples were found to contain VOCs, SVOCs, and inorganic compounds; no pesticides or PCBs were detected. Groundwater samples were collected from monitoring well pairs at four locations at Site 8. A sample from one well indicated the presence of toluene, methylene chloride, endrin, ketone, and inorganic compounds (Fugro-McClelland 1991).

During the Phase I RI field investigation, 37 surface and subsurface soil samples were collected from 12 soil borings located in the eastern part of the site, near the western site boundary, and from borings drilled during the installation of four monitoring wells (Figure 2-29). Four additional monitoring wells were installed at IRP Site 8 during the field activities. Groundwater samples were collected from newly installed wells and from previously installed wells during four quarters of sampling over a 1-year period.

The HHRA performed for IRP Site 8 included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization and the methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). Preliminary COPCs identified for soil in the Phase I RI at Site 8 included VOCs, SVOCs, pesticides/PCBs, and inorganics, including heavy metals. Based on the HHRA, potential human health cancer risks for all receptors are less than EPA's risk management range, for current and future intended uses. Thus, no soil COCs were identified under any human exposure scenario. Additionally, no soil COCs for ecological receptors were identified at IRP Site 8 (TtEMI 2000).

Neither the Phase I RI (TtEMI 2000) nor the RI for Groundwater (TtEMI 2004) identified any pathways for direct human exposure to groundwater at IRP Site 8. The inorganic contaminants detected in groundwater samples during the Phase I field investigation at Site 8 were cadmium, copper, lead, mercury, nickel, silver, and zinc. No organic contaminants were detected in groundwater at the site (TtEMI 2000). TDS results from the sampling showed levels exceeding the RWQCB guidance maximum value of 3,000 mg/L; however, it was determined that the high TDS was not due to contaminant sources at Site 8. Additionally, the human health pathway for municipal groundwater does not exist because the shallow groundwater is not a source of drinking water and does not have beneficial use as a water supply. Detected chemicals, however, were above the acute ambient water quality criteria. Therefore, an ecological risk assessment was recommended (TtEMI 2000).

The COPECs for groundwater identified in the Phase I RI (TtEMI 2000) include copper, mercury, silver, and phosphorus. Those identified in the RI for Groundwater (TtEMI 2004) are nickel and silver. The results of fate and transport modeling of nickel showed that it would take more than 1,000 years for nickel from IRP Site 8 to exceed its screening criterion in groundwater adjacent to ODD No. 2, the surface water receptor. Further, although the potential exists for nickel in groundwater to contribute to concentrations in surface water, nickel is not likely to be bioavailable or to cause significant effects to ecological receptors (TtEMI 2004).

Section 3.3 of this FS describes the risks resulting from contaminants in soil and groundwater at IRP Site 8 and discusses in detail the risk assessment results for the site.

2.3.3.3 Physical Characteristics

This section presents information concerning the site-specific geology, hydrogeology, and surface water hydrology at IRP Site 8.

Geology

The soils at IRP Site 8 have been described based on the boreholes located there. Therefore, lithologic descriptions for IRP Site 8 are limited to the upper 40 feet bgs. The regional geology is described in Section 2.2.4. Soils at IRP Site 8 are located in the unconfined aquifer, which extends to approximately 105 feet bgs. IRP Site 8 soils consist of an upper sand, a clay unit, a sand with silt unit, and a lower sand, all located within the upper portion of the unconfined aquifer. The shallow lithology at IRP Site 8 is shown in Figures 2-30 and 2-31.

The upper sand unit is present at the surface over most of the site, ranging from 1 to 6.5 feet in thickness. This unit contains poorly graded sand, silty sand, and sandy silt with some lenses of clay. Some fill is present in the upper sand, indicated by the presence of gravel and debris. No obvious boundary between the fill and the underlying native material was found from the boring logs. The clay unit underlies the upper sand across the site, and varies in thickness from 1.5 to 15 feet. The clay unit includes clay, silty clay, sandy clay, and clayey sands. A sand with silt unit underlies the clay unit across the site, and ranges from 13 to at least 31 feet in thickness. The unit is poorly graded fine sand and silty sand. The lower sand was observed only in the deep wells at IRP Site 8. It is coarse-grained with very few fines, light to olive brown, and wet. The bottom of the lower sand was not observed in these borings.

Hydrogeology

Groundwater at IRP Site 8 occurs near the ground surface, between 3.5 and 7 feet bgs depending on the season and location (Figures 2-22, 2-23, and 2-24). The elevation of the groundwater is only minimally influenced by tidal activity. Groundwater flow appears to be toward the northeast, with a gradient of approximately 0.002. Hydraulic conductivity values based on slug test data ranged from 0.0004 to 0.011 inch per second, with most values 0.003 inch per second or greater. Hydraulic conductivity and gradient values were used to calculate the groundwater flow velocity. As a result of the variability in hydraulic conductivities, the flow velocity values ranged from 50 to 296 feet per year, with an average of 86 feet per year. IRP Site 8 groundwater exhibits characteristics of saltwater intrusion, with high concentrations of TDS and a sodium-chloride-type chemistry. The high TDS levels exceed the concentration limit set forth for beneficial use aquifers in Policy 88-63, Water Quality Control Plan, Los Angeles Region (RWQCB 1994).

Surface water from IRP Site 8 flows toward ODD No. 2, located 400 feet north of the site. A drainage ditch was previously located closer to the site when the landfill was active. This ditch was likely a conduit for contaminant transport from surface water to the Mugu Lagoon.

2.3.4 IRP Site 9 – Main Base Fire Training Area

IRP Site 9 consists of the main base fire training area. The site is located in the northwestern portion of NBVC Point Mugu, approximately 250 feet from the naval base boundary, and is bordered on the north by Casper and Perimeter Roads (Figure 2-32). IRP Site 9 is approximately 1.5 acres in area, and contains two burn pits. The first is an abandoned, unlined pit 40 feet in diameter, surrounded by a soil berm. This pit contains the remains of an aircraft used for firefighter training. The second pit is similar in size but has a concrete lining to prevent unburned fuel from leaching to the soil and groundwater. The second pit is active and currently is used for firefighter training.

IRP Site 9 is bordered to the north and west by the Ventura County Game Reserve and the Point Mugu Game Reserve, respectively, covering approximately 600 acres (PRC and JMM 1993). A drainage ditch adjacent to Casper Road discharges to the Mugu Lagoon. The site itself is composed of grasslands and nontidal marshes, and is populated by birds and small mammals.

2.3.4.1 History of Use

The original burn pit was used for firefighter training from the late 1950s until 1984. Typical fire training exercises included pouring jet fuel and waste oil products into the pit, igniting them, and then extinguishing the fire with water and chemicals. Unburned liquids then flowed down a drainage ditch to a pit, where they evaporated or infiltrated to the soil. Fire training operations at the old burn pit were shut down in 1984 by order of the Ventura County Environmental Health Department (TtEMI 2000). Approximately 10 percent of the 325,000 gallons of fuel reportedly consumed at the old fire pit was not fully burned (SCS and Landau Associates 1985). Although the majority of the fuel used at the burn pit was jet propellant (JP)-4 and JP-5, waste motor oil and other flammable liquids were used, including alcohol, hydraulic fluid, transmission fluid, transformer fluid, paint thinner, solvents, and carbon tetrachloride (PRC and JMM 1993).

2.3.4.2 Previous Investigations

Several investigations have been performed at IRP Site 9 since the mid-1980s. A preliminary hydrogeologic assessment (Geotechnical Consultants, Inc. 1985) included a collection of soil and groundwater samples from 20 test pits throughout the site. Hydrocarbon contamination was present in the soil and groundwater samples, with total petroleum hydrocarbon (TPH) concentrations ranging from nondetect to 74 mg/L in groundwater and up to 100,000 mg/kg in surface soils southwest of the pit. An IAS (SCS and Landau Associates 1985) gathered historical information, including the types of fuels burned at the old burn pit.

Three soil and groundwater samples were collected during a confirmation study at IRP Site 9 (WESTEC Services, Inc. [WESTEC] and Stollar 1987). Shallow soil samples collected from stained areas north of the fire pit were contaminated with oil and grease, PCBs, phenols, organic lead, and polynuclear aromatic hydrocarbons (PAH). Oil and grease was detected in upgradient and downgradient wells, and phenol was present in groundwater samples from downgradient wells.

During an SI conducted at IRP Site 9 (Fugro-McClelland 1991), soil-gas surveys and cone penetrometer tests were conducted, and soil borings and monitoring wells were installed. Forty-seven soil gas samples were collected from 42 locations at 3.0 and 6.0 foot depths. Twenty-seven soil boring samples were collected from 12 boreholes at 0.5 and 5.0 foot depths. Groundwater samples were collected from 20 cone penetrometer locations at Site 9 and groundwater samples were collected at 5 site monitoring wells. Soil samples were found to be contaminated with VOCs, SVOCs, pesticides, PCBs, total recoverable petroleum hydrocarbons (TRPH), and lead. Groundwater samples contained VOCs, SVOCs, pesticides, PCBs, and lead (TtEMI 2000).

The 1994 Phase I RI field investigation included collection of surface and subsurface soil samples during hollow-stem auger drilling, collection of a surface water samples, monitoring well installation and groundwater sampling, a tidal influence study, and collection of ecological data. Soil boring samples were collected to determine contaminant levels in soils at the old and new fire pits, the drainage swale, and the overflow pit. Samples also were collected from two locations outside the suspected contamination areas. A total of 57 surface and subsurface soil samples were collected from 18 locations within IRP Site 9 (Figure 2-32). Fourteen of the 57 samples were collected from boreholes during the installation of four monitoring wells that were installed downgradient of the old fire pit (TtEMI 2000). Soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, TPH, dioxins and furans, total metals, and physical parameters.

Several of the low features at IRP Site 9, including the old fire pit, the drainage swale, and the overflow pit, have been observed to collect standing water during heavy rains. A sample of standing water was collected from the drainage swale during a storm event.

To supplement the existing monitoring wells, four new monitoring wells were installed as part of the Phase I RI. Two wells were placed at each of the fire pits. Groundwater samples were collected from these new wells and from seven preexisting wells during four quarters of sampling over a 1-year period.

The HHRA performed for IRP Site 9 during the Phase I RI included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). Dioxins and furans were detected in soil at the old fire-training pit during the Phase I RI. Most of the contaminants at IRP Site 9 are centered on the new fire ring and the old fire training pit and associated drainage swale and overflow pit. Preliminary COPCs identified for soil in the Phase I RI included VOCs, SVOCs, pesticides/PCBs, dioxins and furans, and inorganics, including heavy metals. Section 3.4 of this FS provides a summary of the distribution of contaminants in soil, results of the HHRA in the Phase I RI (TtEMI 2000), results of the ecological risk characterization, and the contaminant and site risks for soil at IRP Site 9.

Although a number of ecological COPCs were identified in soil during the Phase I RI at IRP Site 9, these chemicals were detected at very low concentrations and at low frequencies. Thus, no soils COPECs for ecological receptors were identified at IRP Site 9.

Inorganic contaminants detected above National Ambient Water Quality Criteria in groundwater at IRP Site 9 are copper, mercury, nickel, silver, and zinc in three monitoring wells installed on the site. Two VOCs were detected in groundwater at IRP Site 9; however, the maximum detected concentrations for these VOCs do not exceed the screening levels presented in EPA's vapor intrusion guidance and no further evaluation is necessary for this pathway. The groundwater contaminants at IRP Site 9 that were identified and evaluated in the RI for Groundwater (TtEMI 2004) are cobalt, copper, molybdenum, nickel, and zinc. No COPCs were identified for groundwater at IRP Site 9 during the RI for Groundwater (TtEMI 2004).

2.3.4.3 Physical Characteristics

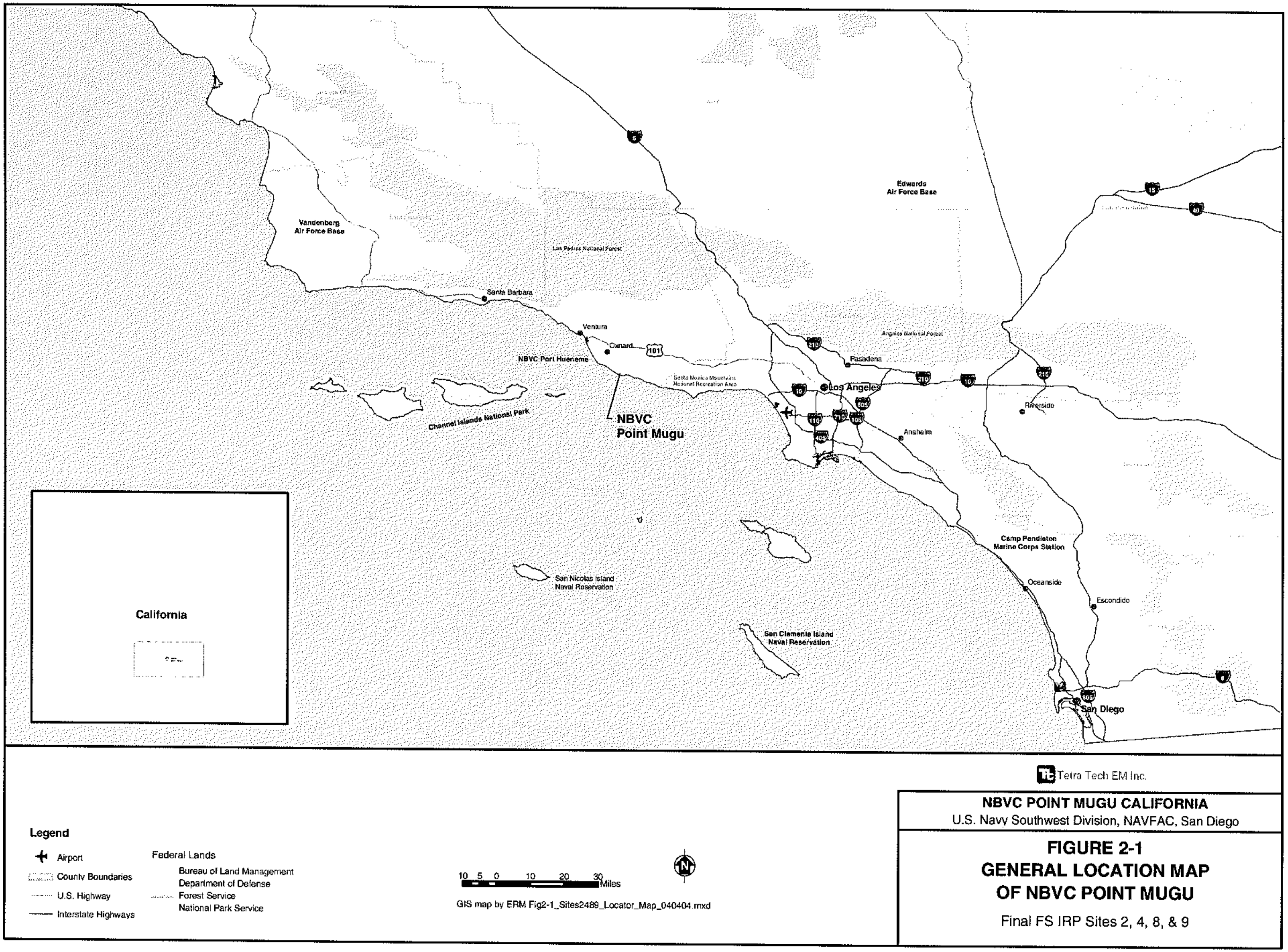
The soils at IRP Site 9 have been described based on the boreholes located there. Therefore, lithologic descriptions for IRP Site 9 are limited to the upper 21 feet bgs. The regional geology is described in Section 2.2.4. Soils at IRP Site 9 are located in the unconfined aquifer, which extends to approximately 110 feet bgs. Site 9 soils consist of a silt unit, a clay unit, and a sand unit, all located within the upper portion of the unconfined aquifer (Figures 2-33 and 2-34).

The silt unit is present at the surface over a portion of the site, ranging from 0 to 5.5 feet in thickness. This unit contains mostly silt with some clayey and sandy silt. The clay unit underlies the silt unit, and is exposed at the surface where the silt unit is not present. The clay unit varies in thickness from 1.5 to more than 14 feet, and consists of clay, sandy clay, and clayey silt. A sand unit underlies the clay unit across the site. The bottom of the sand layer was not encountered during the investigations at IRP Site 9. The unit is poorly graded fine- to coarse-grained sand and silty sand, with some clay lenses.

Groundwater at IRP Site 9 occurs near the ground surface, between 3.5 and 7 feet bgs depending on the season and location (Figures 2-22, 2-23, and 2-24). The elevation of the groundwater is only minimally influenced by tidal activity. Groundwater flow appears to be toward the northeast, with a gradient of approximately 0.001 to 0.003. Hydraulic conductivity values based on slug test data ranged from 0.001 to 0.017. Hydraulic conductivity and gradient values were used to calculate the groundwater flow velocity. As a result of the variability in hydraulic conductivities, the flow velocity values ranged from 34 to 920 feet per year, with an average of 318 feet per year. IRP Site 9 groundwater exhibits characteristics of saltwater intrusion, with high concentrations of TDS and a sodium-chloride-type chemistry. The high TDS levels exceed the concentration limit set forth for beneficial use aquifers in Policy 88-63, Water Quality Control Plan, Los Angeles Region (RWQCB 1994).

Drainage Ditch No. 1 is located several hundred feet from IRP Site 9 to the north, west, and south, and several game reserve duck ponds are located 500 feet to the north. Surface water from IRP Site 9 likely infiltrates the soil prior to reaching the drainage ditch system.

FIGURES

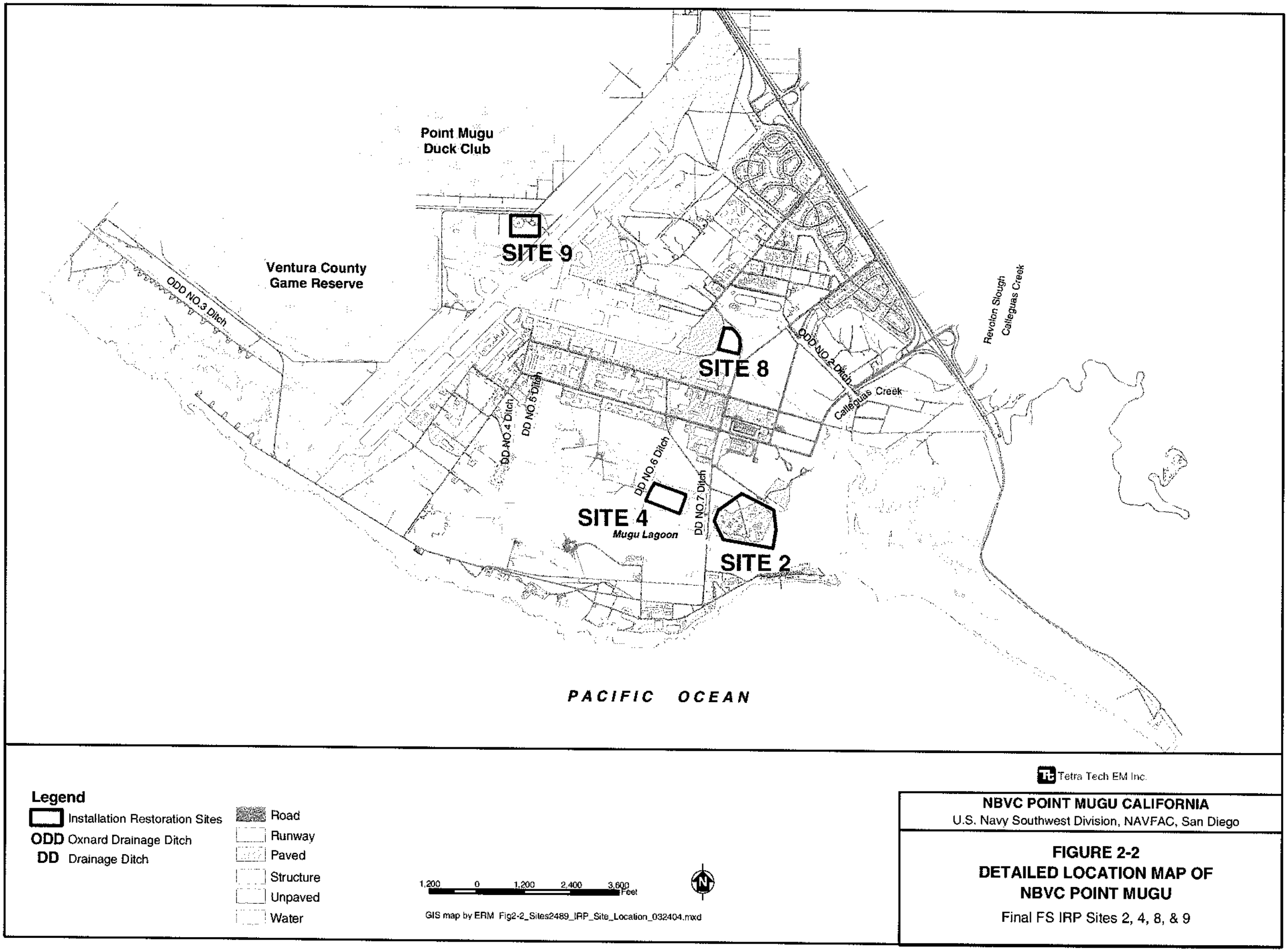


Tetra Tech EM Inc.

NBVC POINT MUGU CALIFORNIA
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-1
GENERAL LOCATION MAP OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9

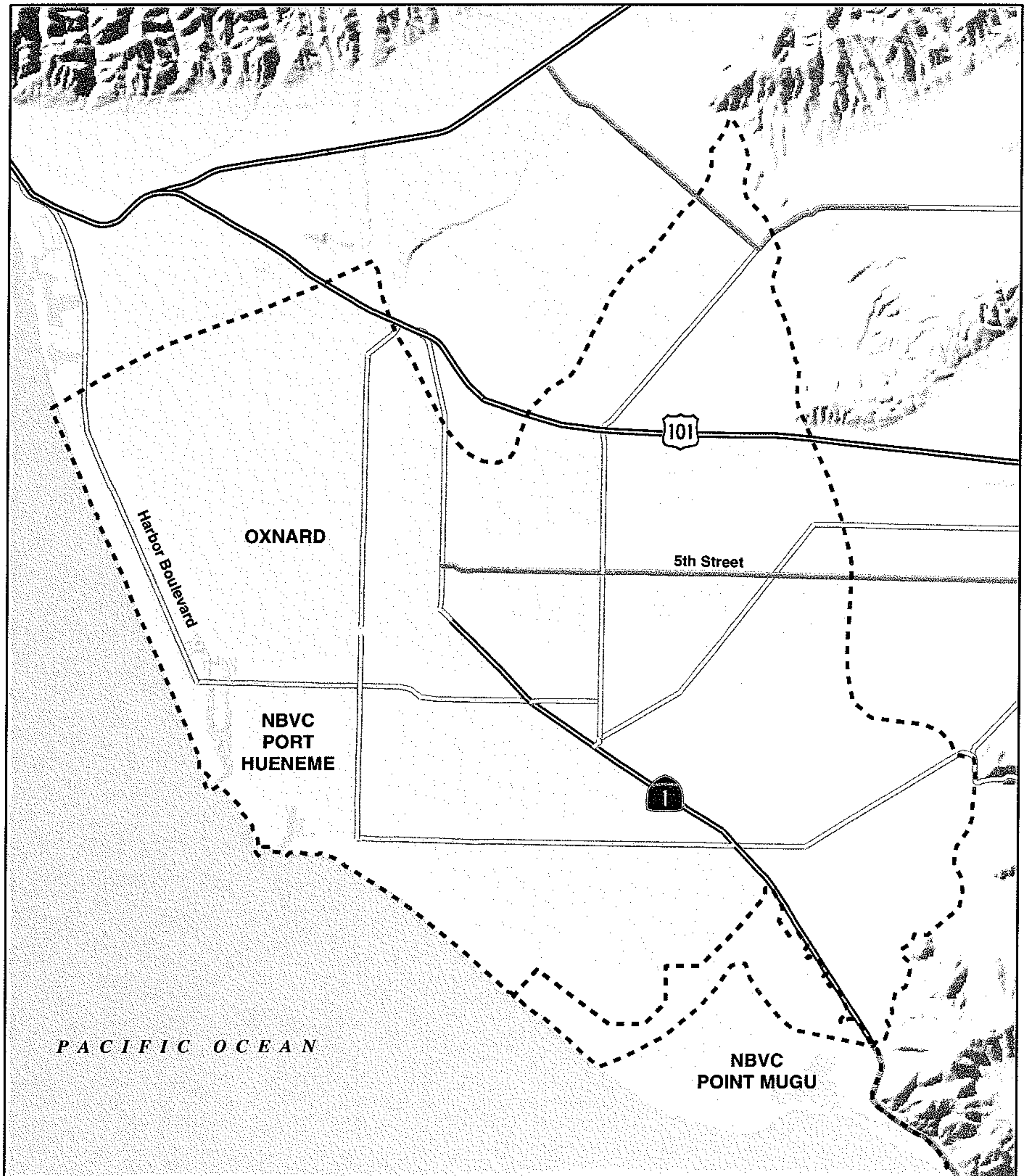


Tetra Tech EM Inc.

NBVC POINT MUGU CALIFORNIA
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-2
DETAILED LOCATION MAP OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9



Legend

NBVC Point Mugu Boundary

Extent of Oxnard Plain

Major Roads

Limited Access Freeway

Highway

Secondary Roads

1 0 1 2 Miles

GIS map by ERM Fig2-3_Sites2489_Oxnard_Plain_040204.mxd
Data Source: Tetra Tech EMI GIS databases

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U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-3
LOCATION AND EXTENT OF THE OXNARD PLAIN

Final FS IRP Sites 2, 4, 8, & 9

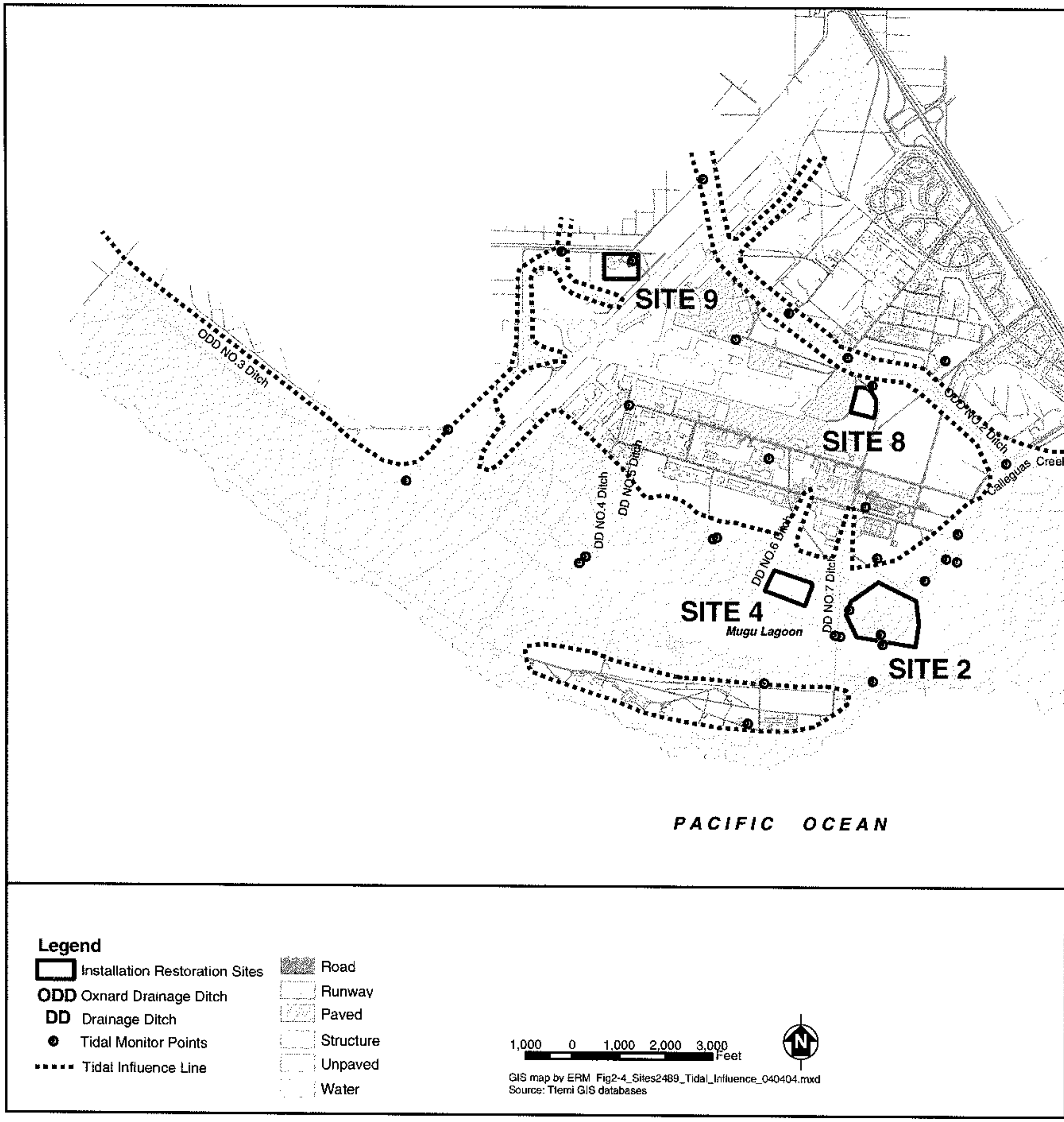

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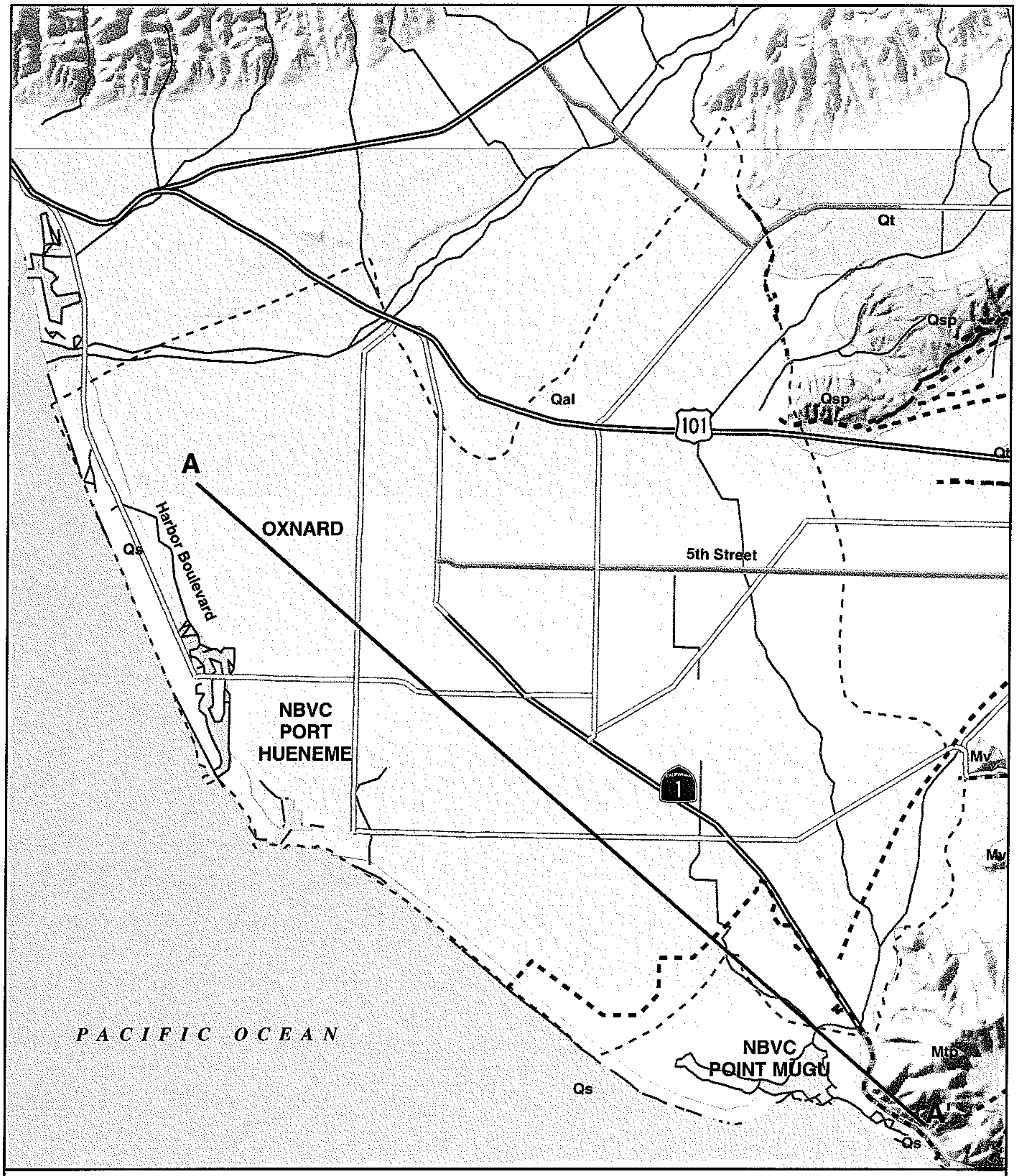
FIGURE 2-4
CONFIGURATION OF MUGU LAGOON

Final FS IRP Sites 2, 4, 8, & 9



Legend

Qsp	Pleistocene
Mtp	Lower to Middle Miocene
Mv	Miocene Volcanics
Qal	Quaternary Alluvium
Qs	Quaternary Dune Sand
Qt	Quaternary Terraces

NBVC Point Mugu Boundary

Extent of Oxnard Plain

1 0 1 2 Miles

GIS map by ERM Fig2-4_Sites2489_Regional_Geology_050504.mxd
Data Source: Tetra Tech EMI GIS databases
Jennings and Strand, 1969 and Ventura County

N

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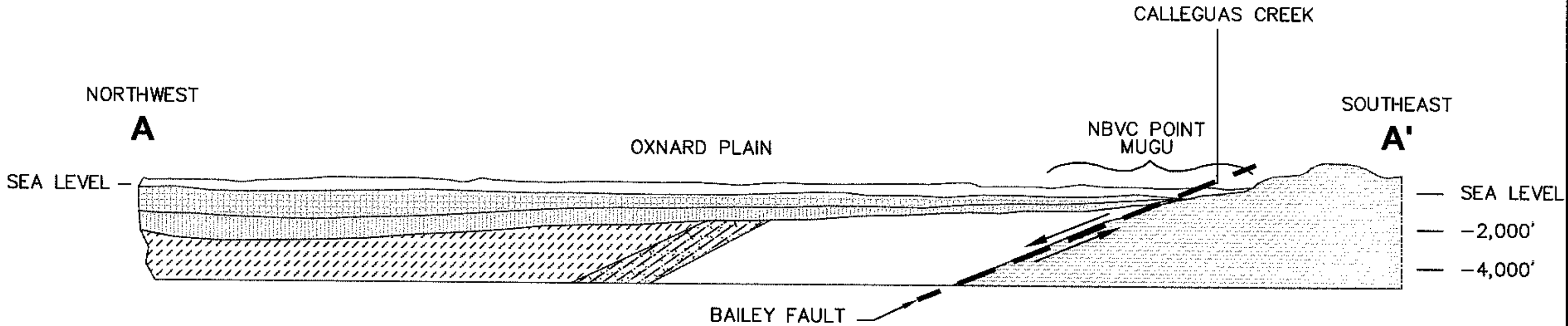
FIGURE 2-5
NBVC REGIONAL GEOLOGY

Final FS IRP Sites 2, 4, 8, & 9



LEGEND

- Qal – QUATERNARY ALLUVIUM
- Qsp – LOWER PLEISTOCENE (SAN PEDRO FORMATION)
- PQsb – LOWER PLEISTOCENE TO PLIOCENE (SANTA BARBARA FORMATION)
- Pp – PLIOCENE (PICO FORMATION)
- Mmsh – MIOCENE (SANTA MARGARITA AND MODELO FORMATION)
- Mtp – LOWER TO MIDDLE MIOCENE (TOPANGA FORMATION)
- Mv – MIOCENE VOLCANICS
- BAILEY FAULT (ARROWS INDICATE RELATIVE DISPLACEMENT)

NOTE:
CROSS SECTION LINE A–A' IS PRESENTED ON FIGURE 2–5.

NOT TO SCALE

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FIGURE 2-6
REGIONAL GEOLOGIC CROSS-SECTION

Final FS IRP Sites 2, 4, 8, & 9

SOURCE: MODIFIED FROM CALIFORNIA DEPARTMENT OF WATER RESOURCES–1965

Fig 2-6_reg geo x-sect.dwg - DWH - 03/30/2004 - G9016.007.04.12.02.04.18

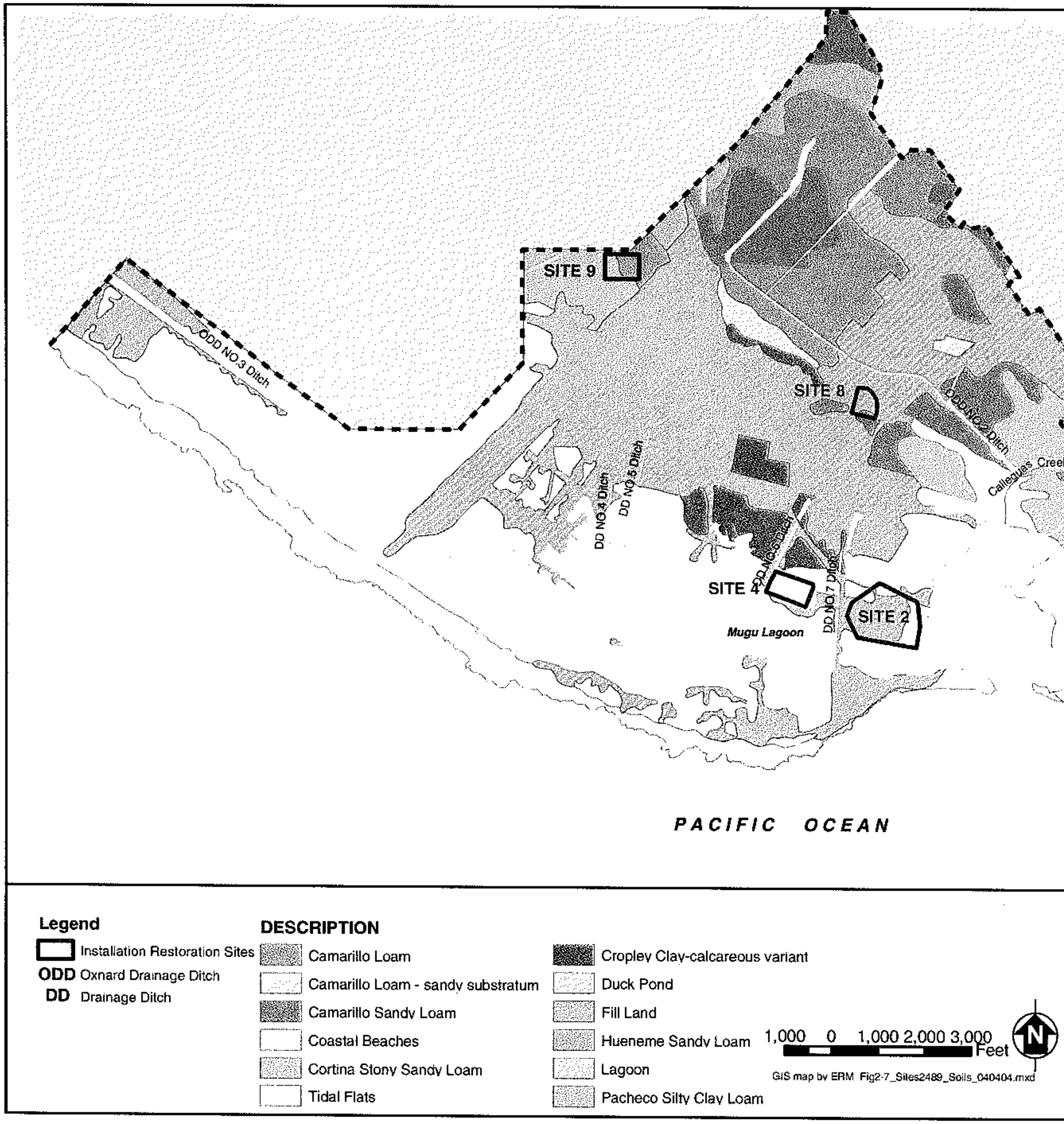

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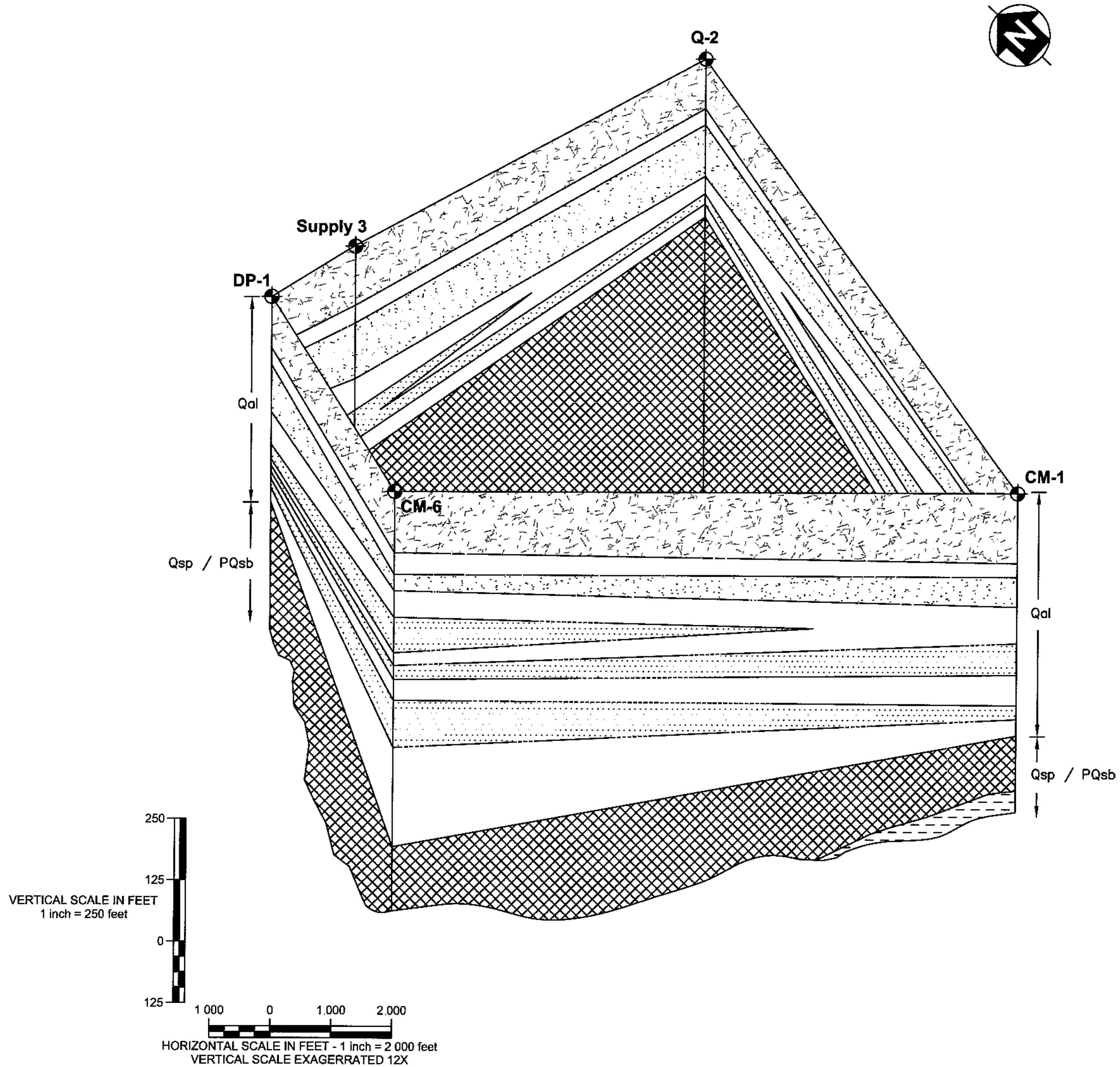
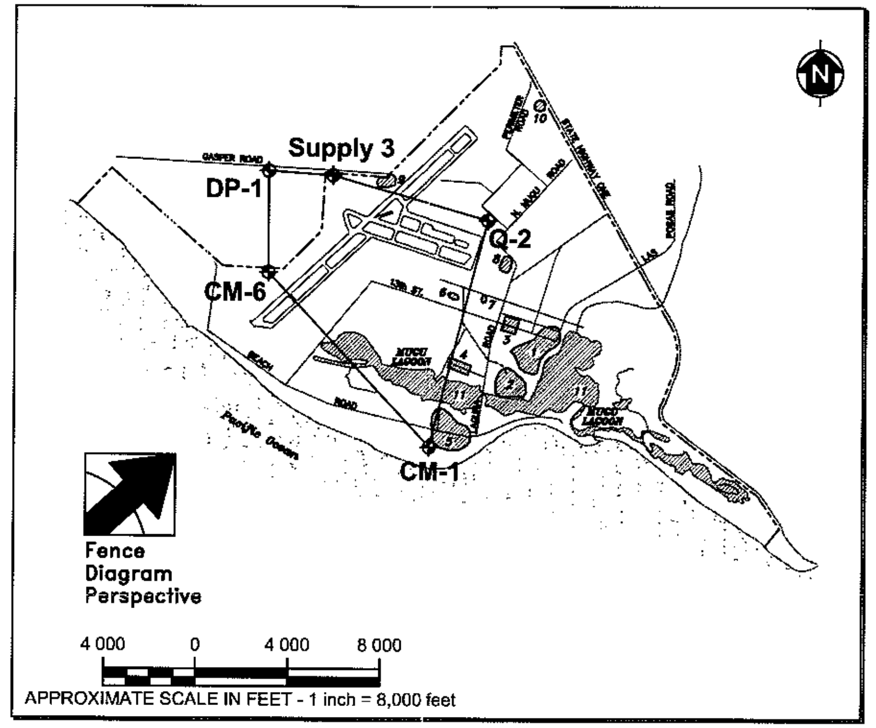
FIGURE 2-7
DISTRIBUTION OF SURFICIAL SOILS AT NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9





LEGEND

⯁	WELLS USED IN FENCE DIAGRAM CONSTRUCTION
	SEMI PERCHED AQUIFER
	OXNARD AQUIFER
	MUGU AQUIFER
	FOX CANYON & GRIMES CANYON AQUIFER
	BASALT
Qal	QUARTERNARY ALLUVIUM
Qsp	LOWER PLEISTOCENE (SAN PEDRO FORMATION)
PQsb	LOWER PLEISTOCENE TO LOWER PLIOCENE (SANTA BARBARA FORMATION)

SOURCE: PRC–1995

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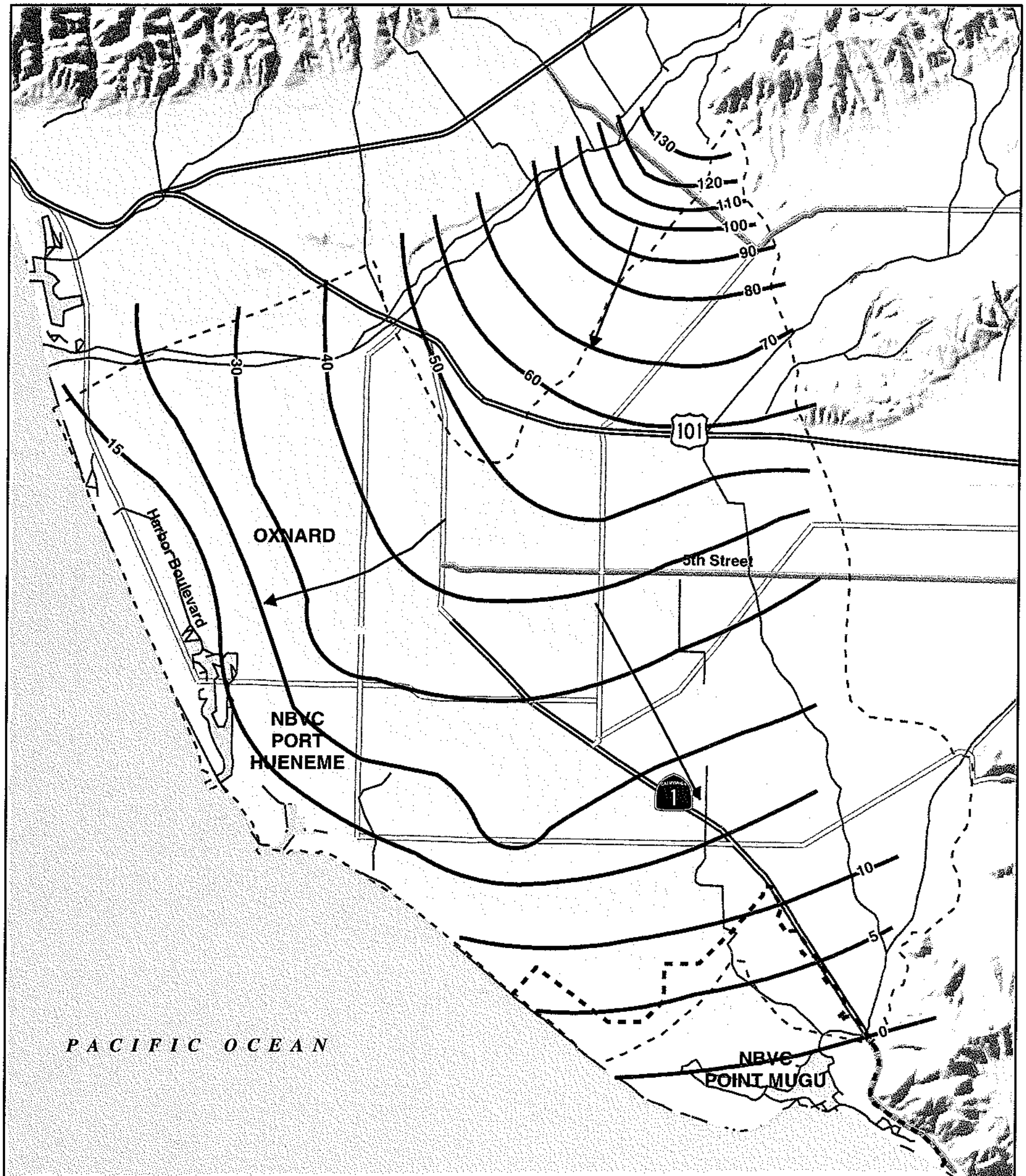
FIGURE 2-8
HYDROGEOLOGICAL FENCE DIAGRAM

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-8_hydro fence dgrm.dwg - DWH - 03/30/2004 - G9016.007 04 12 02 04 18



Legend

- Flow direction
- -20- Feet above MSL
- NBVC Point Mugu Boundary
- Extent of Oxnard Plain

Major Roads

- Limited Access Freeway
- Highway
- Secondary Roads

1 0 1 2 Miles

N

GIS map by ERM Fig2-9_Sites2489_Groundwater_Upper_040404.mxd
Data Source: Tetra Tech EMI GIS databases
Groundwater Contours from the United Water Conservation District 1999

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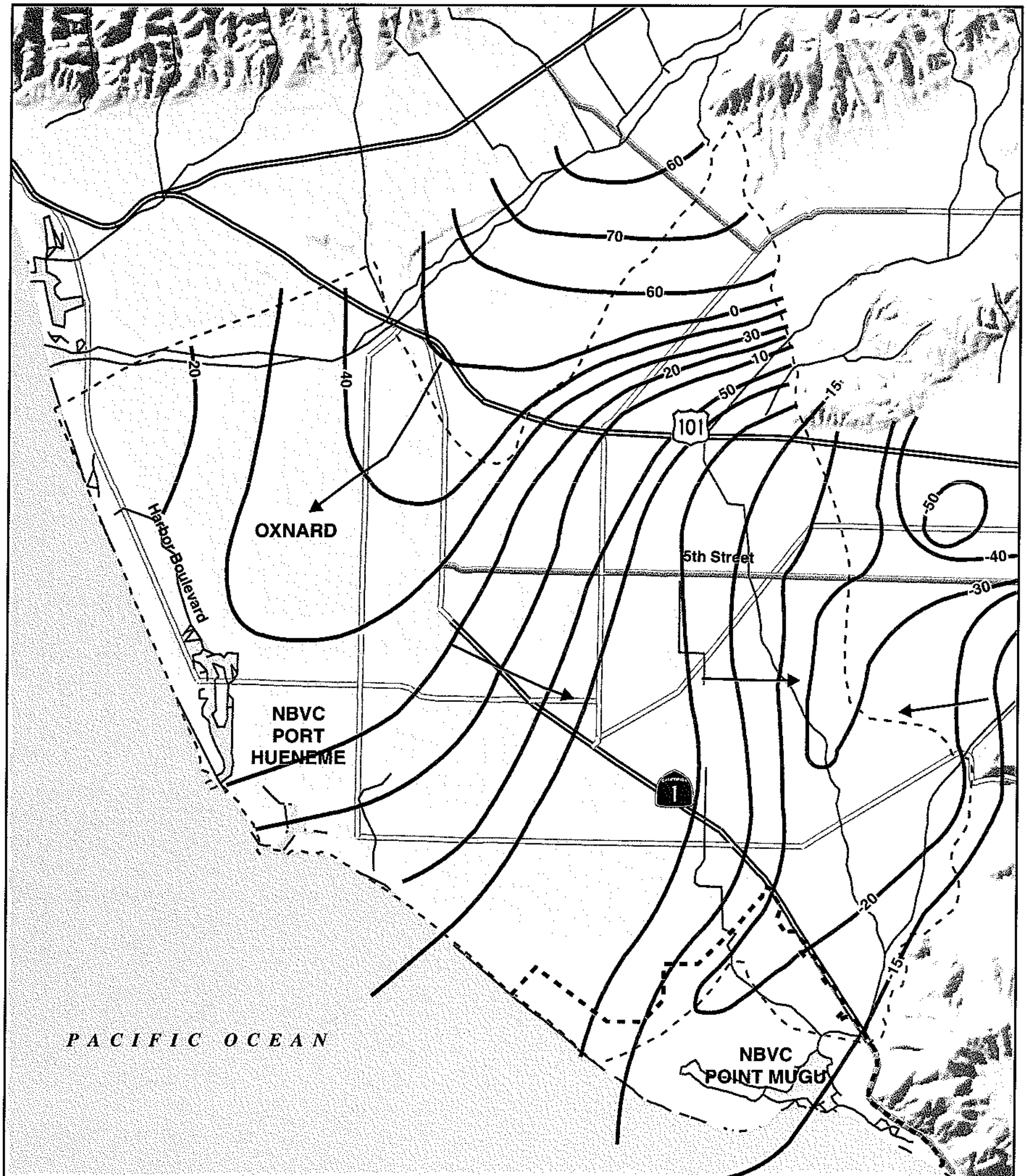
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-9
GROUNDWATER ELEVATION CONTOURS FOR THE UPPER AQUIFER SYSTEM
SPRING 1998

Final FS IRP Sites 2 4 8 & 9



Legend

- Flow direction
- -20- Feet above MSL
- NBVC Point Mugu Boundary
- Extent of Oxnard Plain

Major Roads

- Limited Access Freeway
- Highway
- Secondary Roads

1 0 2 Miles

GIS map by ERM Fig2-10_Sites2489_Groundwater_Lower_040404.mxd
Data Source: Tetra Tech EMI GIS databases
Groundwater Contours from the United Water Conservation District 1999

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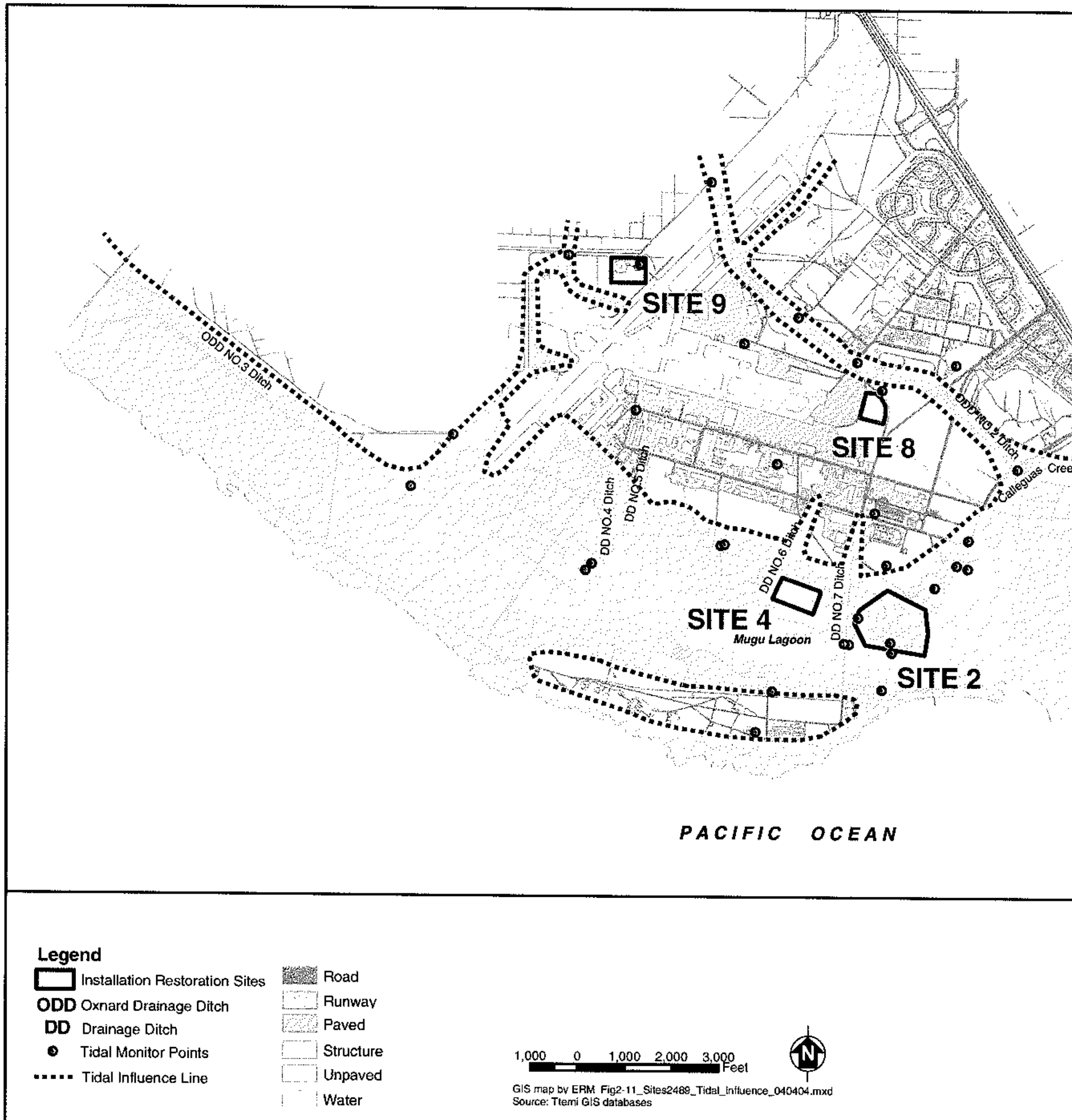
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-10
GROUNDWATER ELEVATION CONTOURS FOR THE LOWER AQUIFER SYSTEM
SPRING 1998

Final FS IRP Sites 2, 4, 8, & 9



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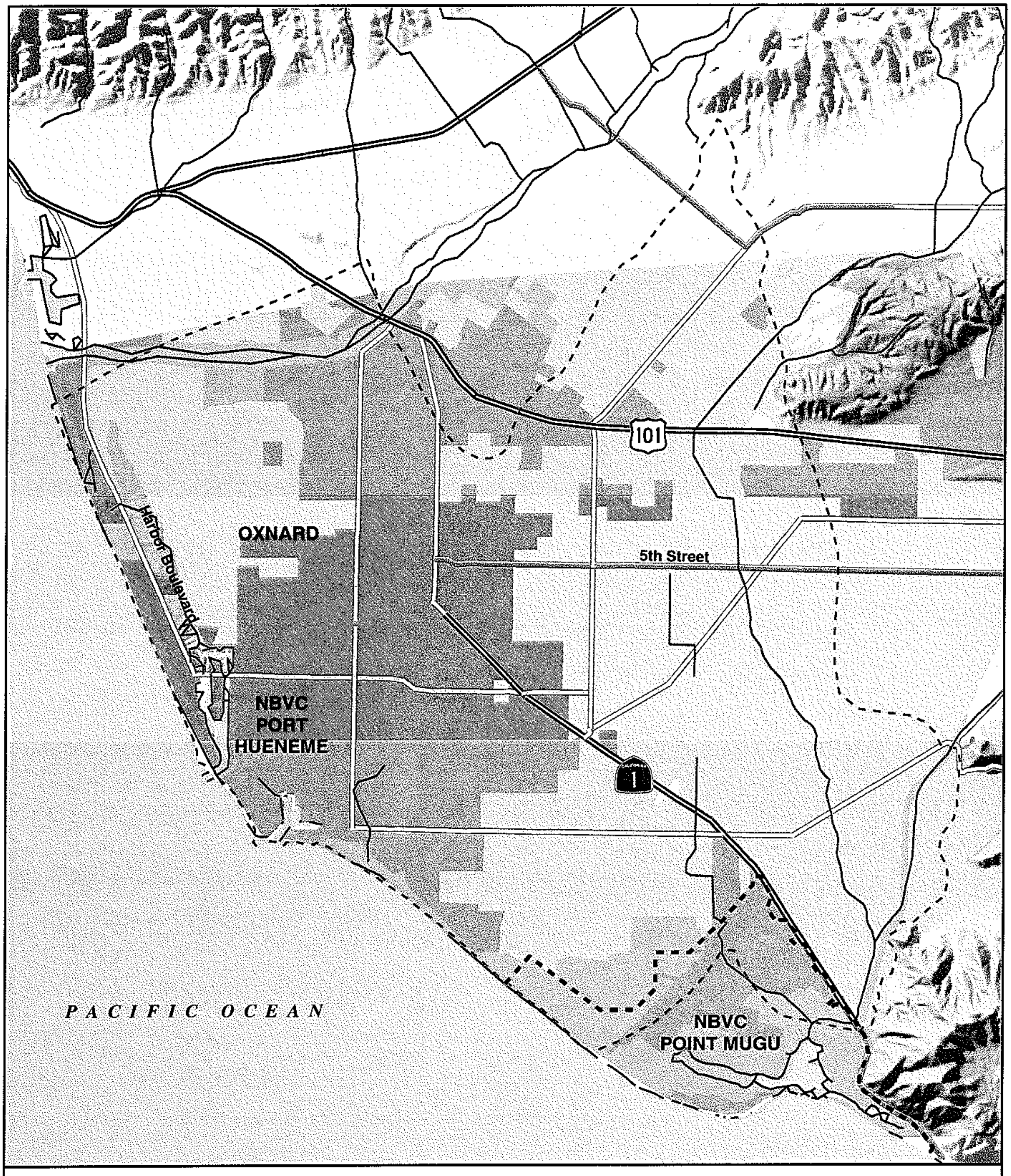
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-11
AREA OF TIDAL INFLUENCE IN SURFACE WATER AND THE UNCONFINED AQUIFER

Final FS IRP Sites 2, 4, 8, & 9



Legend

- - - NBVC Point Mugu Boundary

Extent of Oxnard Plain

Major Roads

Limited Access Freeway

Highway

Secondary Roads

Land Use

Developed/Urban

Agriculture

Open Space/Parkland

1 0 2 Miles

GIS map by ERM Fig2-12_Sites2489_Landuse_040404.mxd
Data Source: Tetra Tech EMI GIS databases
Land Use from Ventura County GIS 2002

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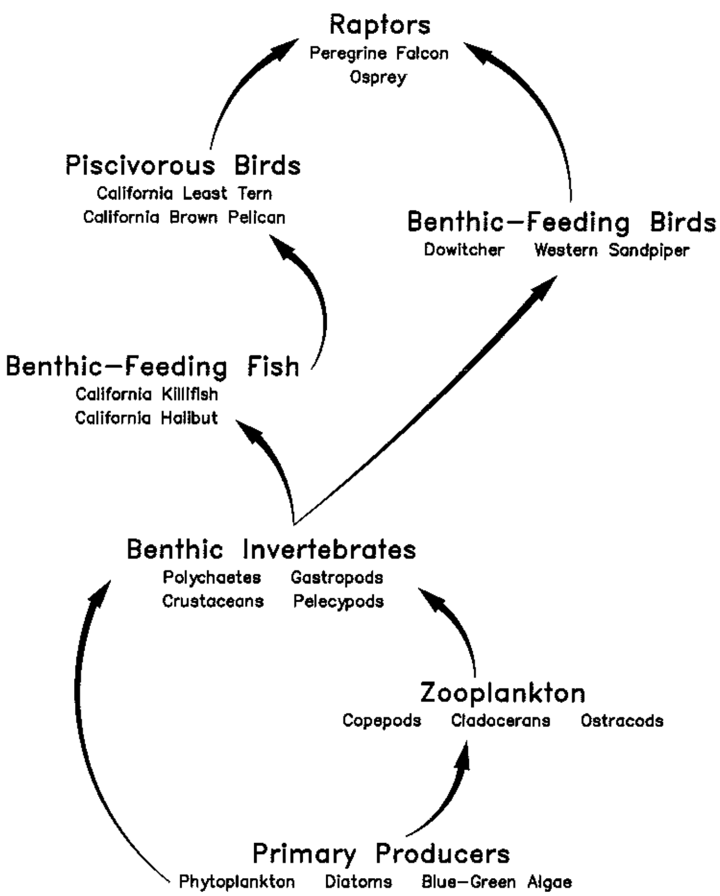
FIGURE 2-12
LAND USE OF
THE OXNARD PLAIN

Final FS IRP Sites 2 4 8 & 9



NOTE:
Species under each guild heading vary in actual diet composition.

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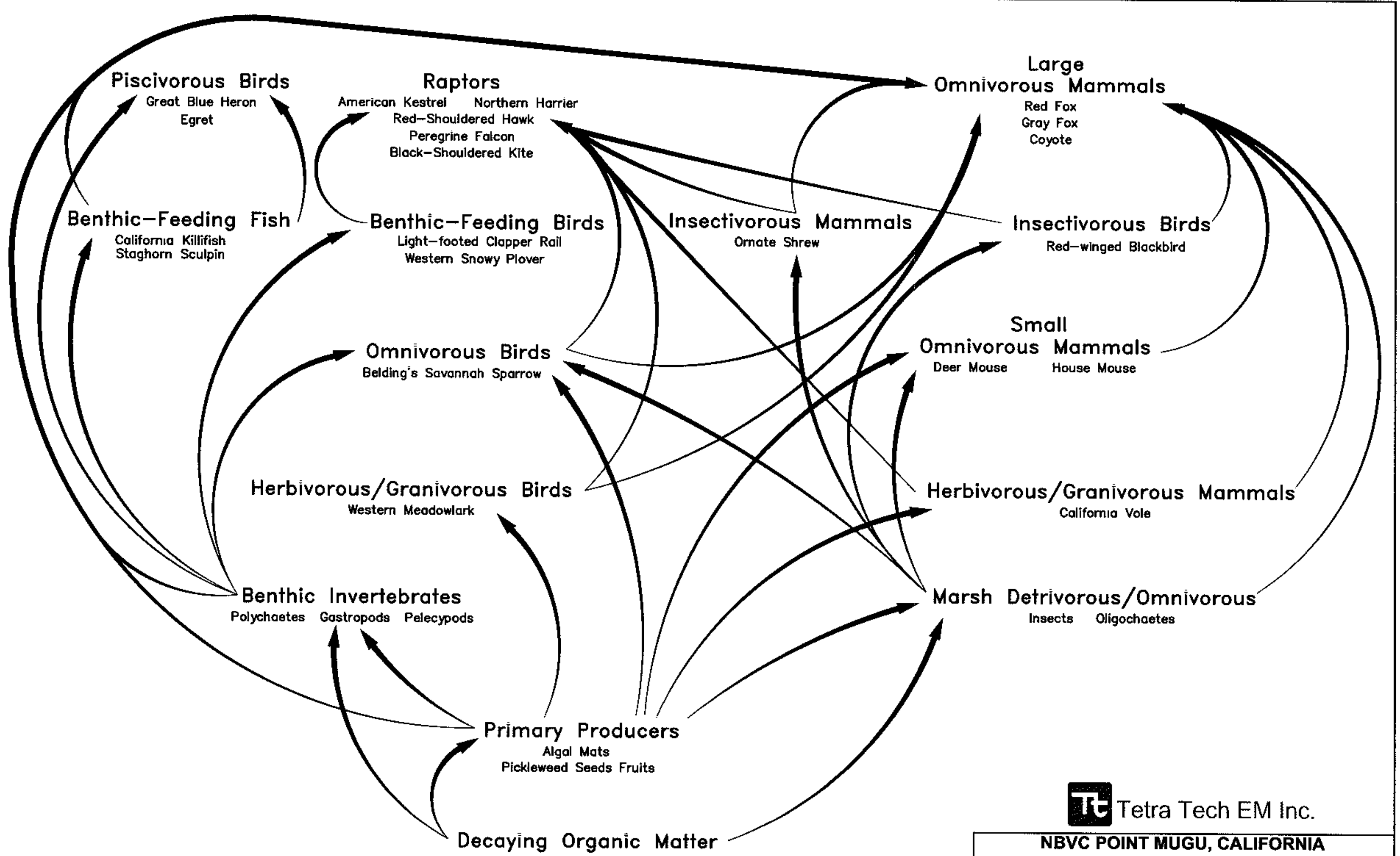
FIGURE 2-13
OPEN-WATER FOOD WEB OF MUGU LAGOON

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-13_open water food web.dwg - DWH - 03/30/2004 - G9016.007.04.12.02.04.18



NOTE:
Species under each guild heading vary in actual diet composition.

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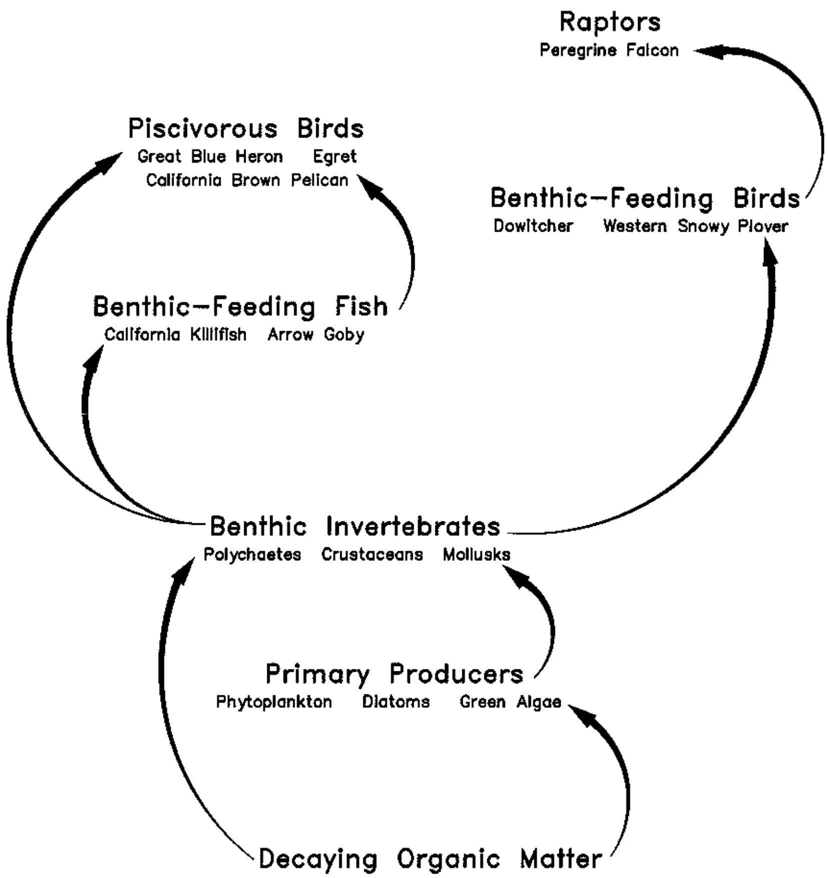
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-14
TIDAL MARSH FOOD WEB OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9



NOTE:
Species under each guild heading vary in actual diet composition.

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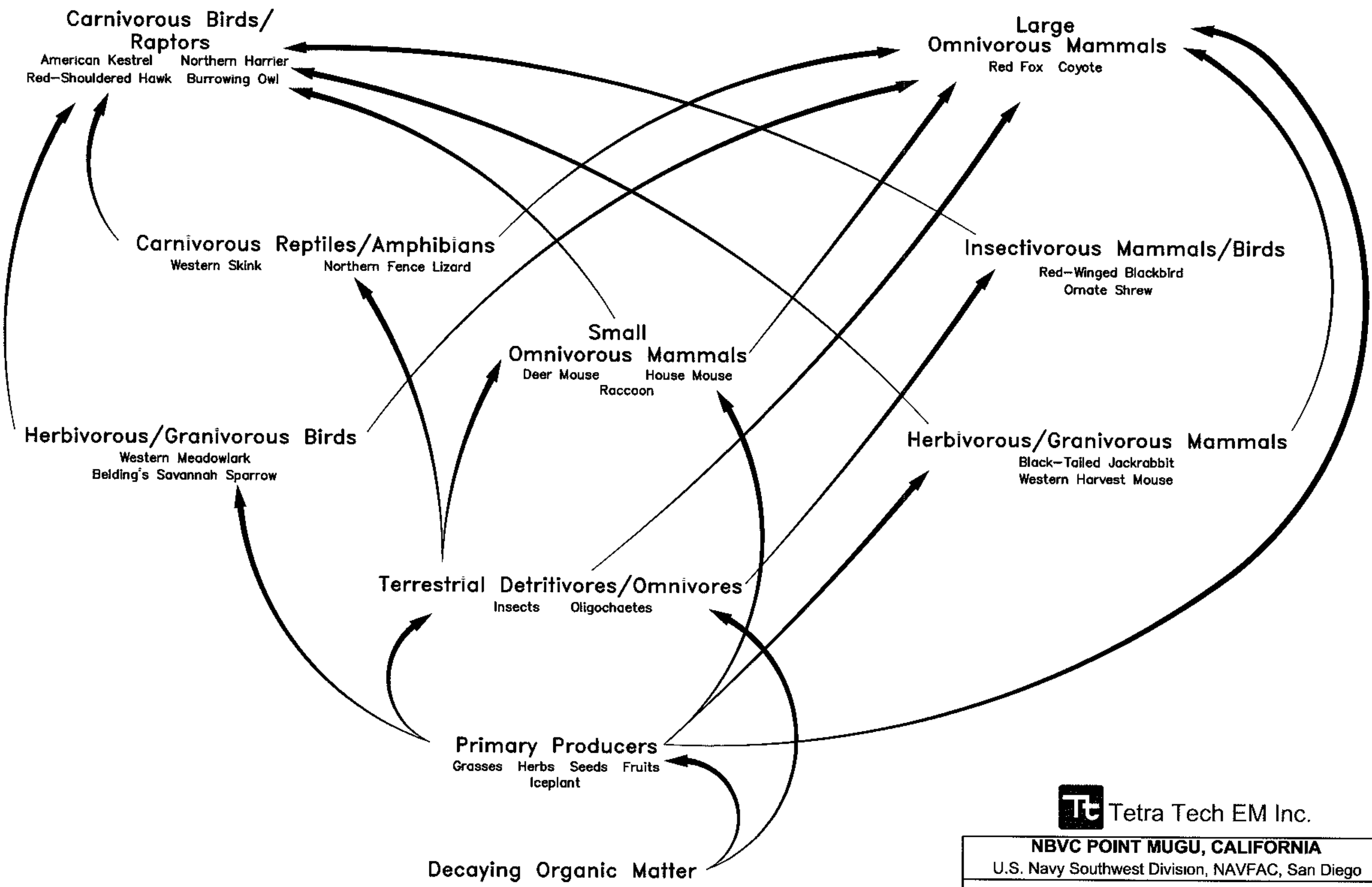
FIGURE 2-15
INTERTIDAL MUDFLAT FOOD WEB OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9



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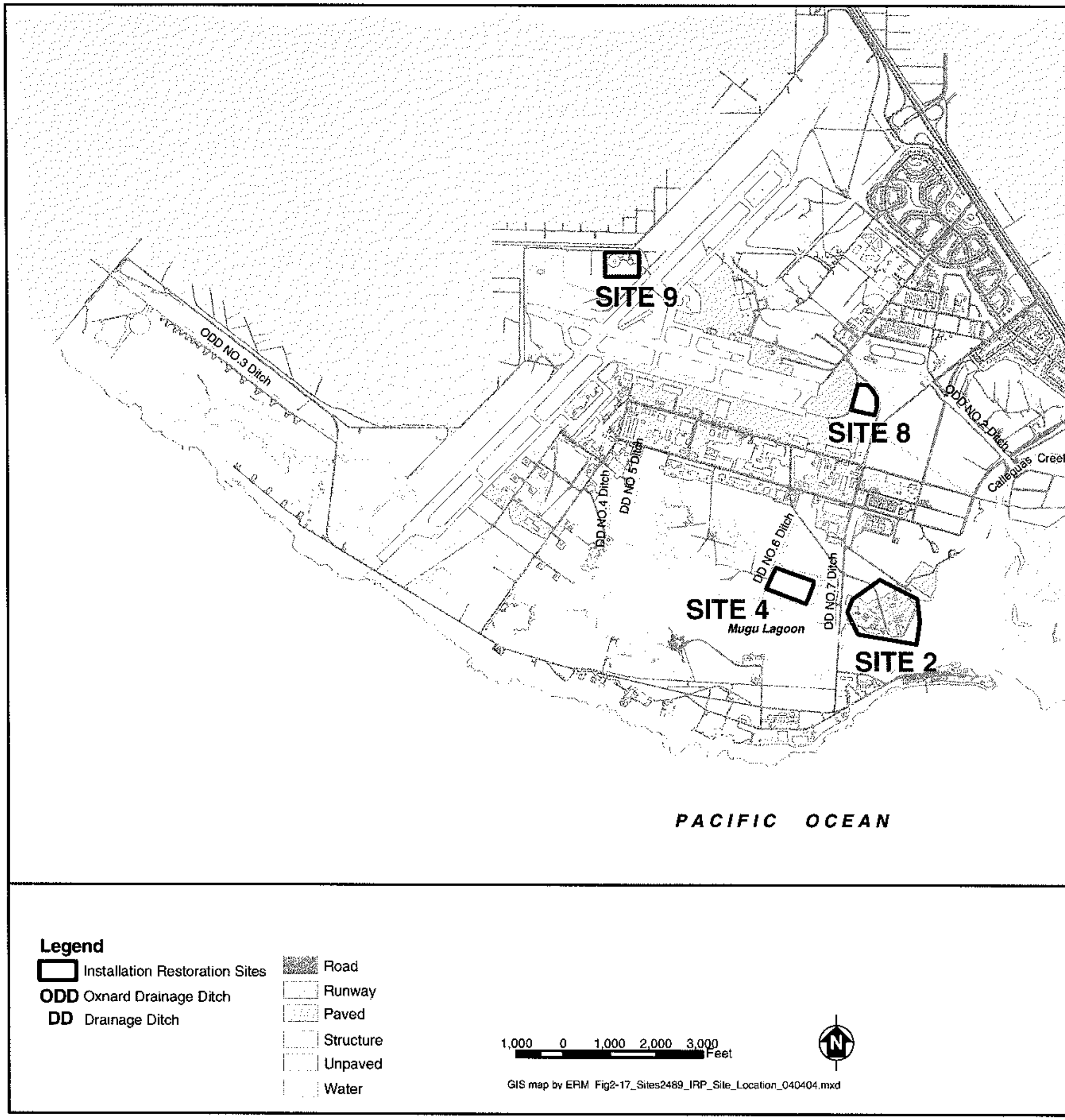
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-16
UPLAND FOOD WEB
OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9

NOTE:
Species under each guild heading vary in actual diet composition.

Fig 2-16_upland food web.dwg - DWH - 03/30/2004 - G9016.007.04.12.02.04.18



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U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-17
LOCATION OF INSTALLATION RESTORATION PROGRAM SITES AT NBVC

Final FS IRP Sites 2, 4, 8, & 9

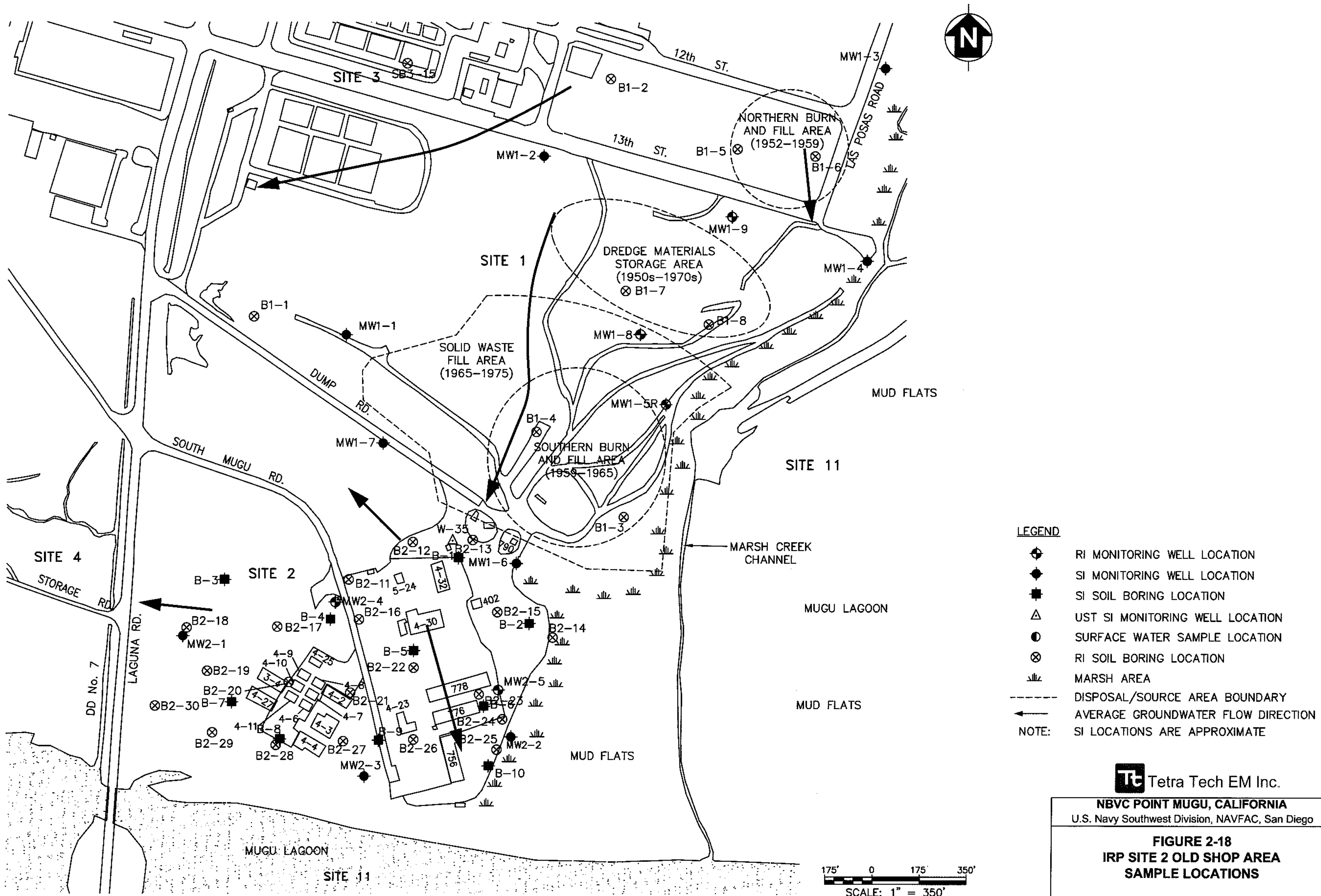

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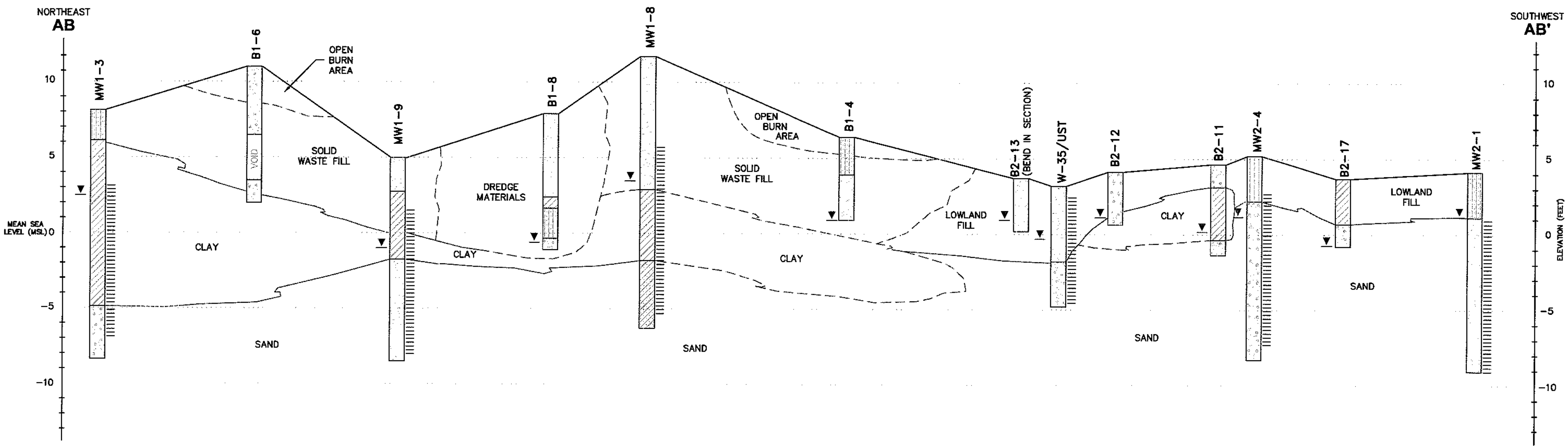
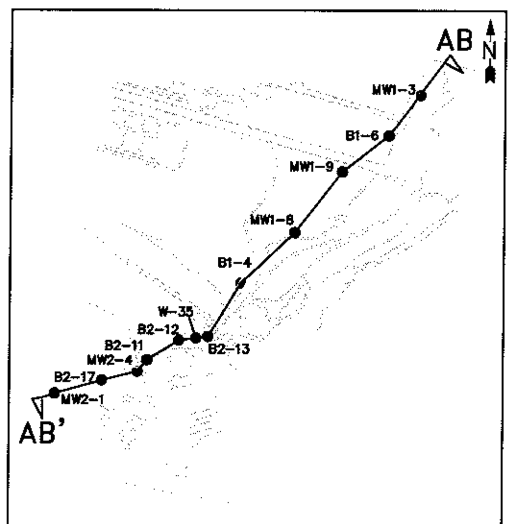
FIGURE 2-18
IRP SITE 2 OLD SHOP AREA SAMPLE LOCATIONS

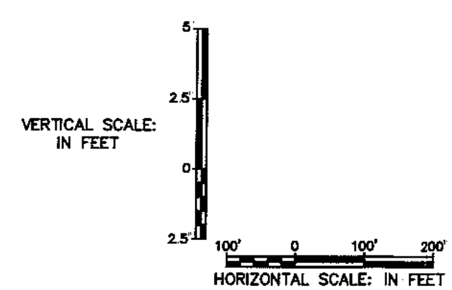
Final FS IRP Sites 2, 4, 8, & 9

Fig 2-18 shop samp loc.dwg - DWH - 03/30/2004 - G9016.007.04 12.02.04.18





SITES 1 & 2 LOCATION MAP



VERTICAL EXAGGERATION IS 40X.

LEGEND

- SW – WELL-GRADED SANDS
- SP – POORLY-GRADED SANDS
- SM – SILTY SANDS
- SC – CLAYEY SANDS
- ML – SANDY SILTS, CLAYEY SILTS
- CL – SANDY CLAYS, SILTY CLAYS
- CONTACT
- INFERRED CONTACT
- APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL

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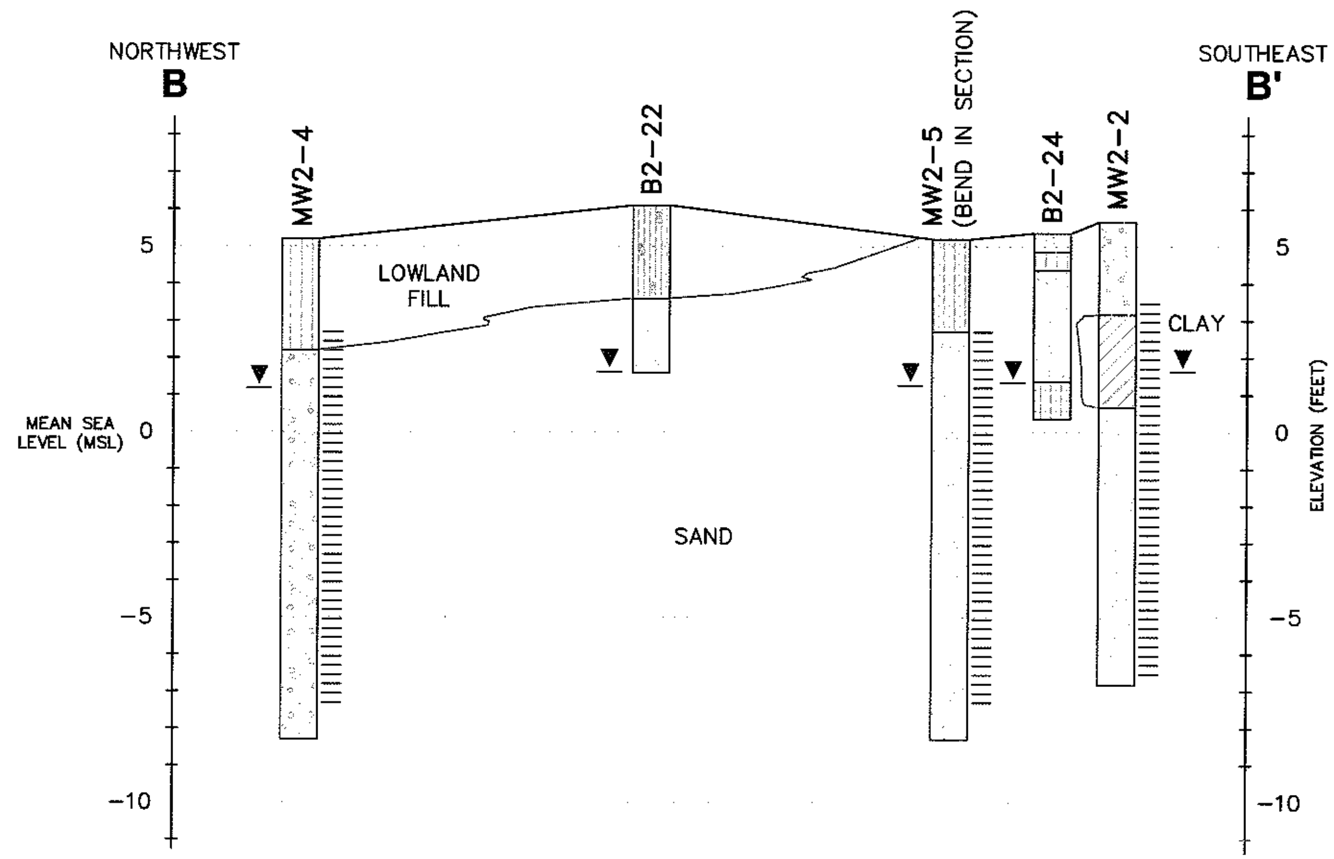
U.S. Navy Southwest Division, NAVFAC, San Diego

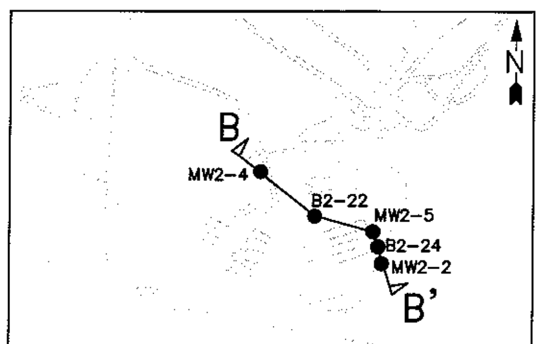
FIGURE 2-19
IRP SITE 2 OLD SHOPS AREA
GEOLOGICAL CROSS-SECTION AB-AB'

Final FS IRP Sites 2, 4, 8, & 9



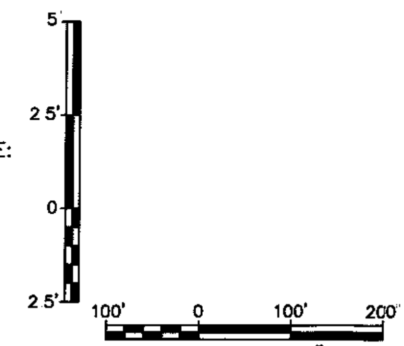
LEGEND

- GM – SILTY GRAVELS
- SW – WELL-GRADED SANDS
- SP – POORLY-GRADED SANDS
- SM – SILTY SANDS
- ML – SANDY SILTS, CLAYEY SILTS
- CL – SANDY CLAYS, SILTY CLAYS
- CONTACT
- ▼ APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL



SITE 2 LOCATION MAP

VERTICAL SCALE:
1" = 5'



HORIZONTAL SCALE: 1" = 200'

VERTICAL EXAGGERATION IS 40X.

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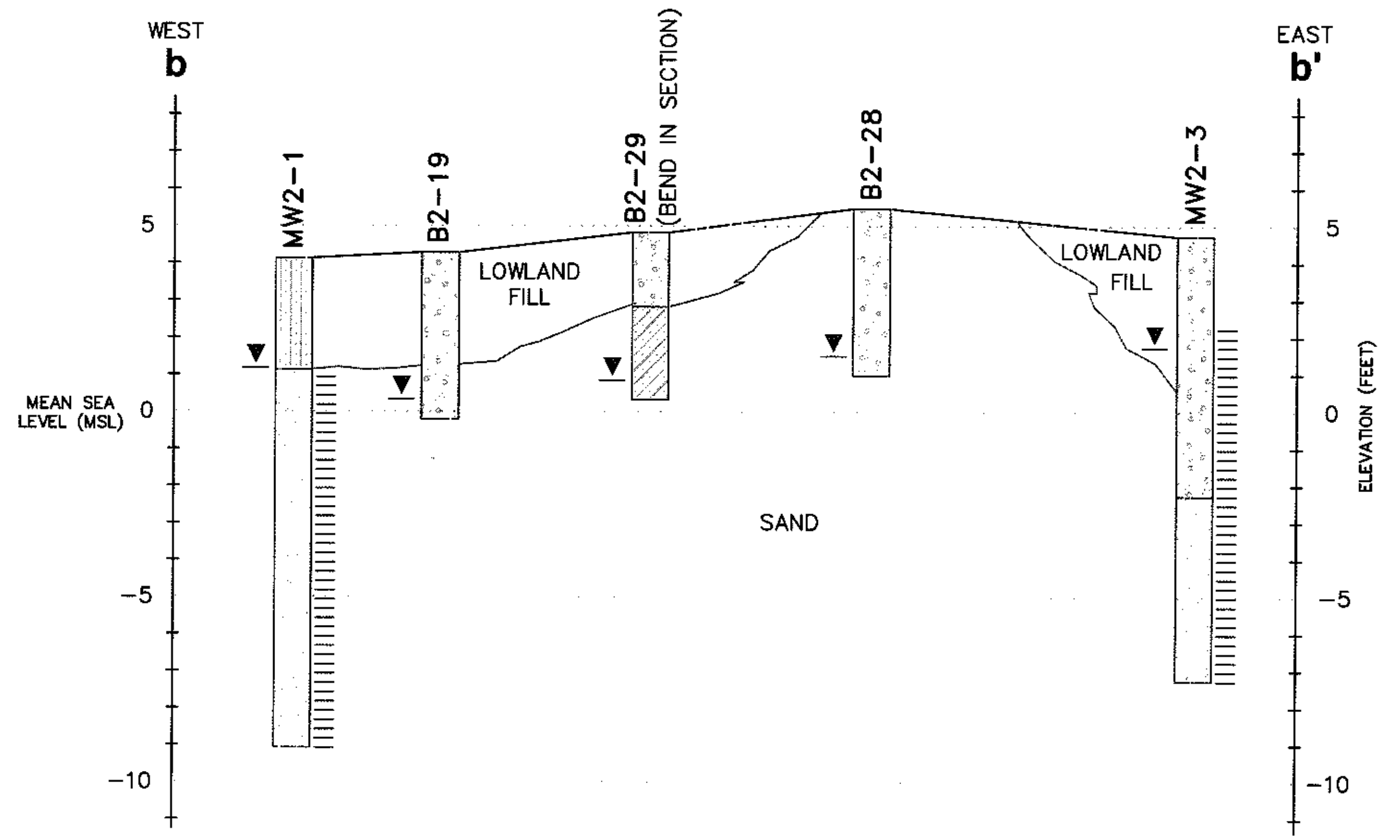
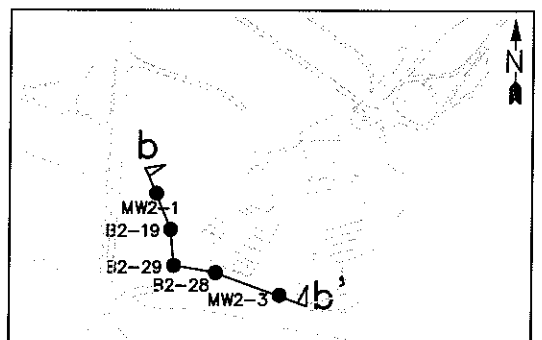
FIGURE 2-20
IRP SITE 2 OLD SHOPS AREA
GEOLOGICAL CROSS-SECTION B-B'

Final FS IRP Sites 2, 4, 8, & 9

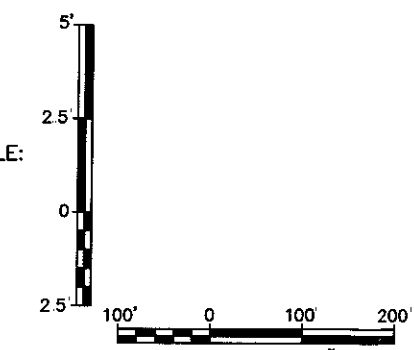


LEGEND

- SW – WELL-GRADED SANDS
- SP – POORLY-GRADED SANDS
- SM – SILTY SANDS
- SC – CLAYEY SANDS
- CONTACT
- APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL



SITE 2 LOCATION MAP



VERTICAL SCALE: 1" = 5'

HORIZONTAL SCALE: 1" = 200'

VERTICAL EXAGGERATION IS 40X.

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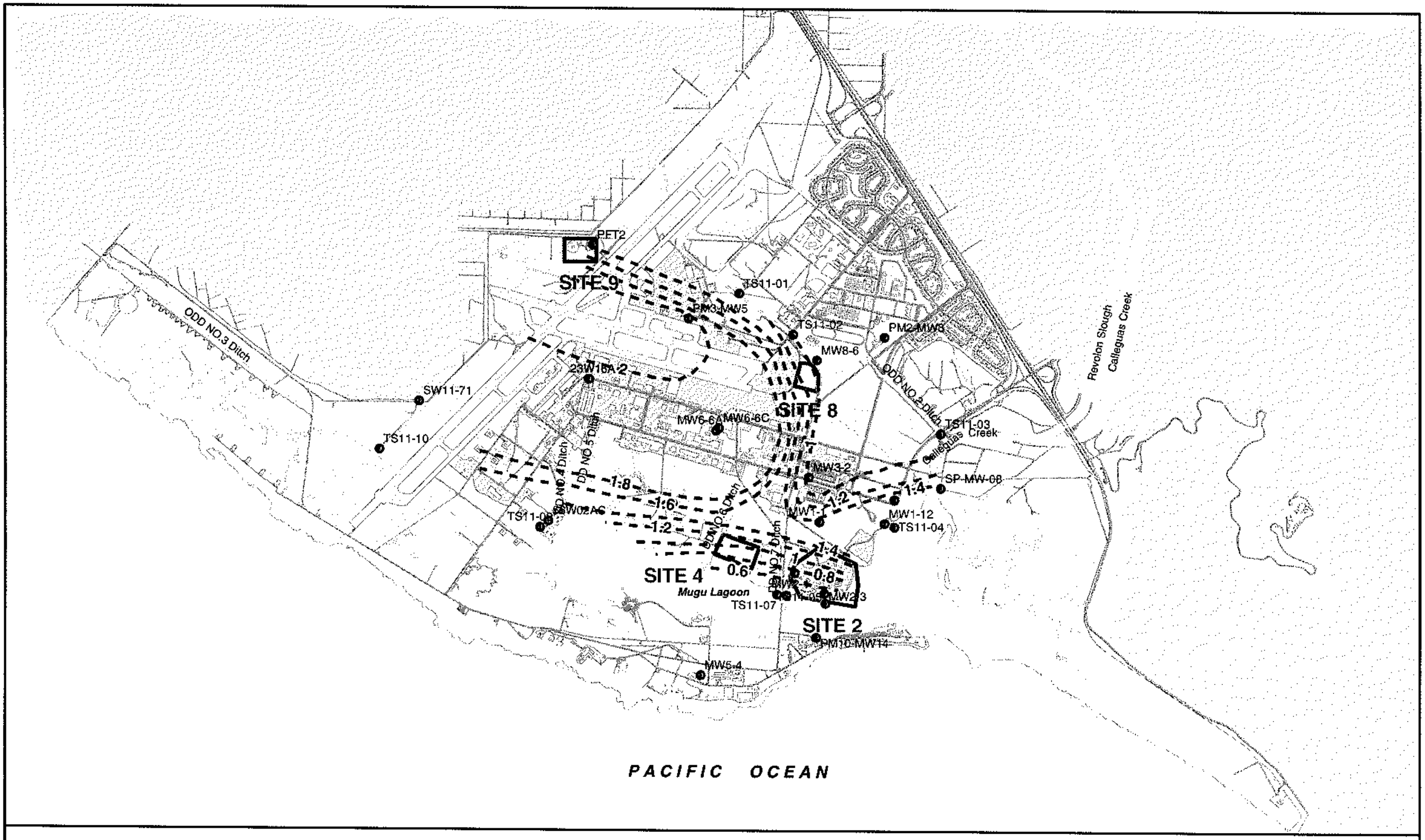
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-21
IRP SITE 2 OLD SHOPS AREA
GEOLOGICAL CROSS-SECTION b-b'

Final FS IRP Sites 2, 4, 8, & 9



Legend

- Installation Restoration Sites
- Tidal Study Monitoring Points
- Groundwater Elevations
- Road
- Runway
- Paved
- Structure
- Unpaved
- Water

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FIGURE 2-22
MEAN GROUNDWATER ELEVATION CONTOURS FIRST QUARTER
JUNE 22-25, 1998

Final FS IRP Sites 2, 4, 8, & 9

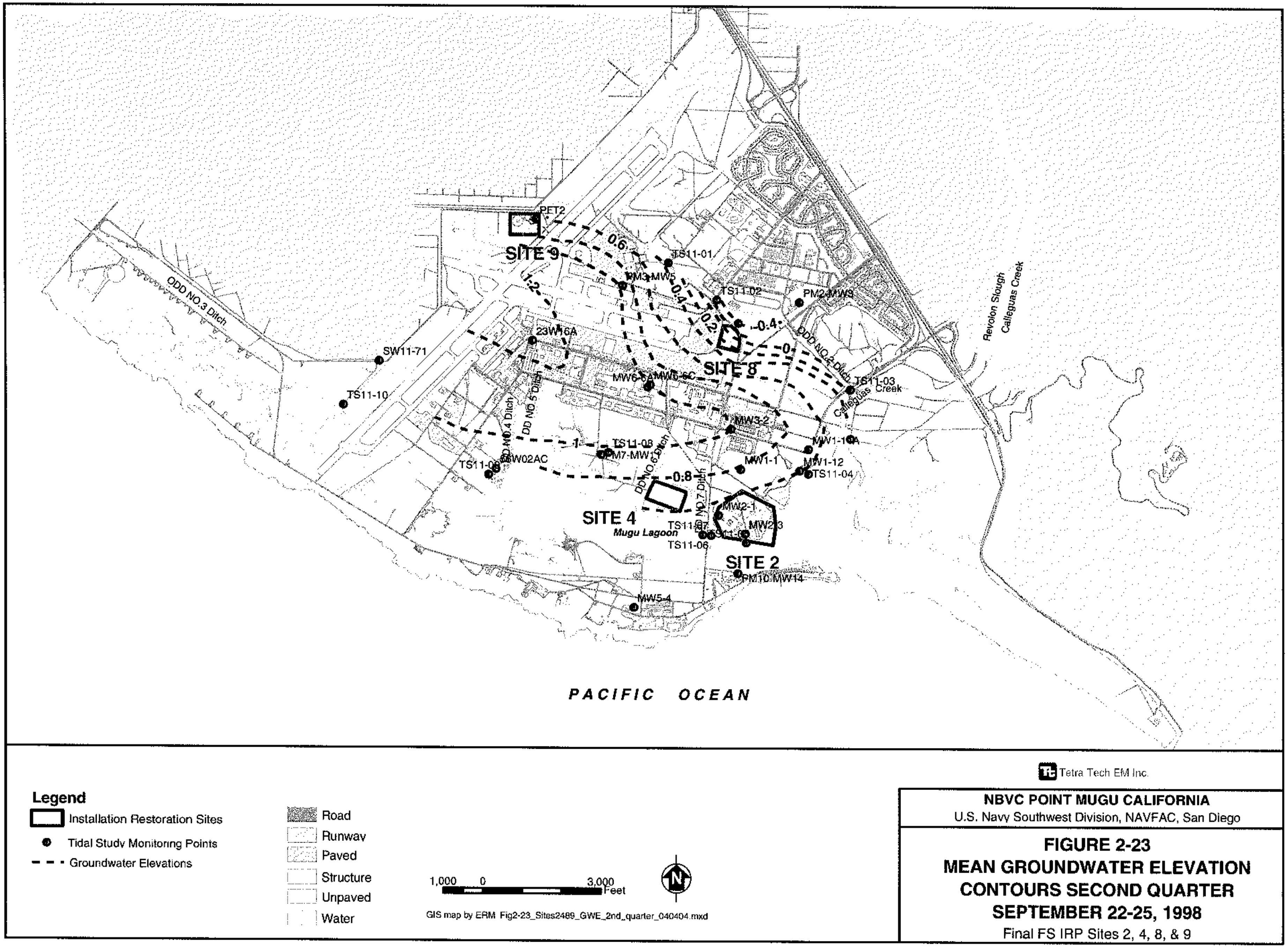

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FIGURE 2-23

MEAN GROUNDWATER ELEVATION CONTOURS SECOND QUARTER SEPTEMBER 22-25, 1998

Final FS IRP Sites 2, 4, 8, & 9

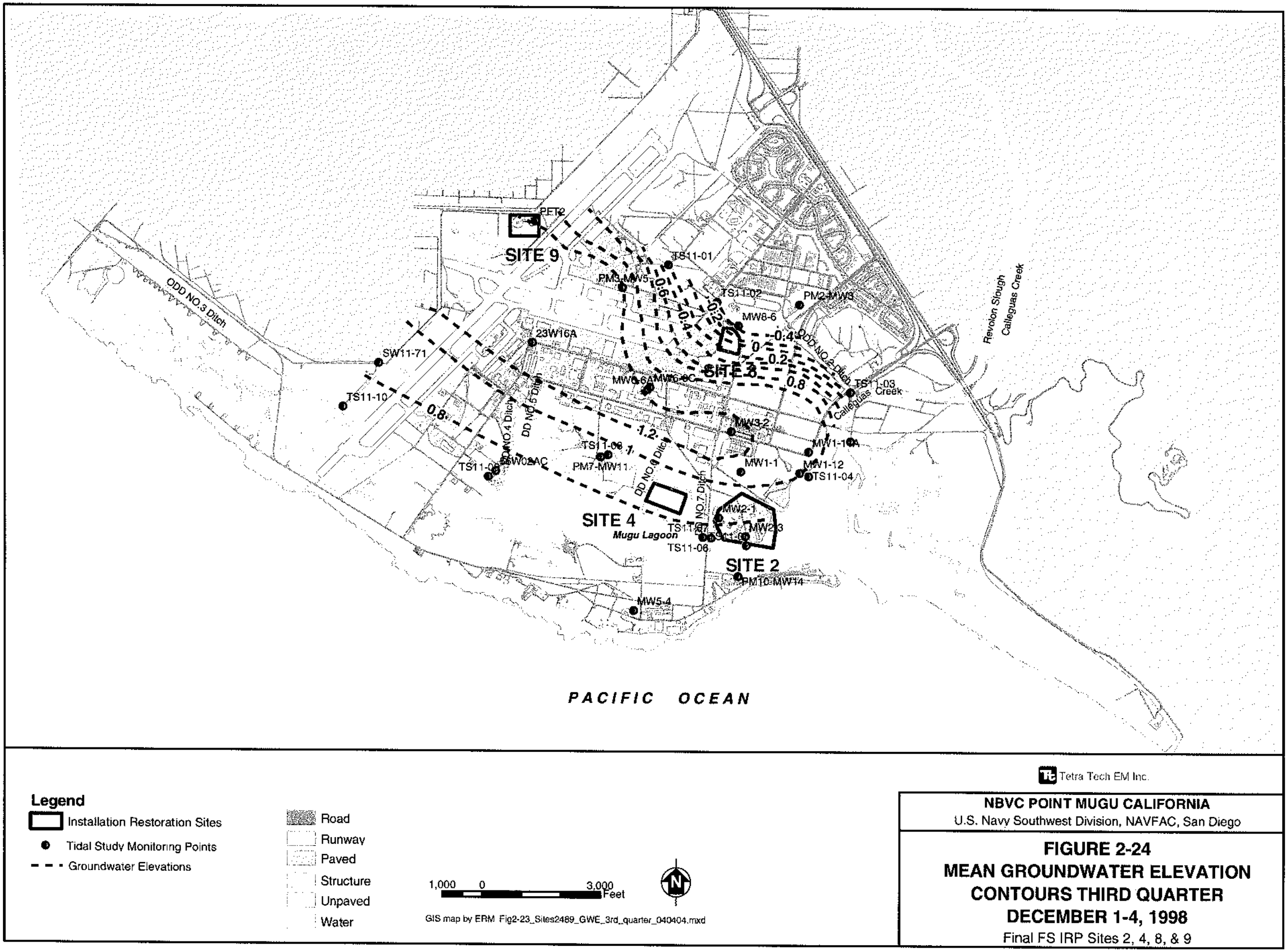

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FIGURE 2-24
MEAN GROUNDWATER ELEVATION CONTOURS THIRD QUARTER
DECEMBER 1-4, 1998

Final FS IRP Sites 2, 4, 8, & 9

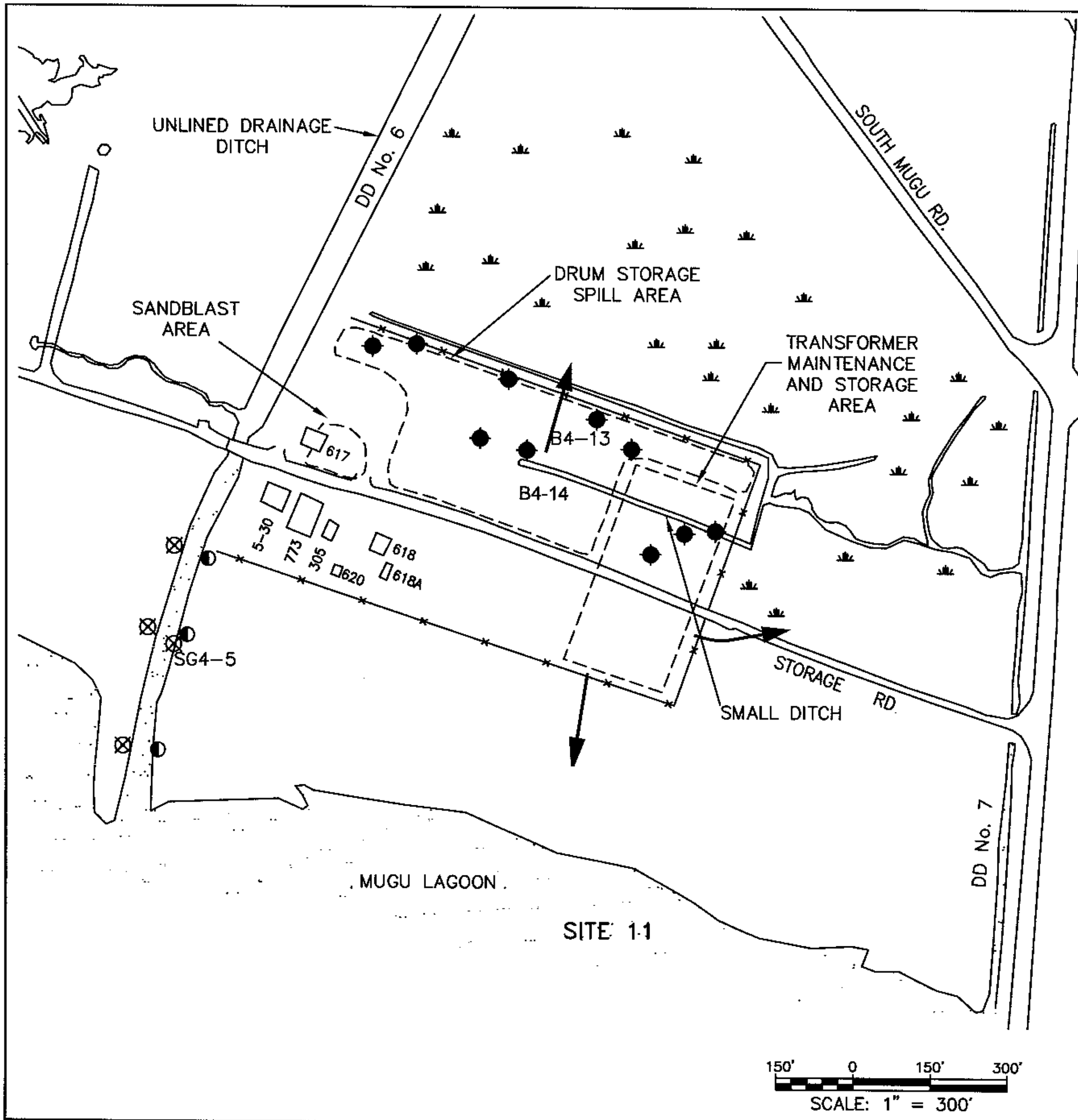

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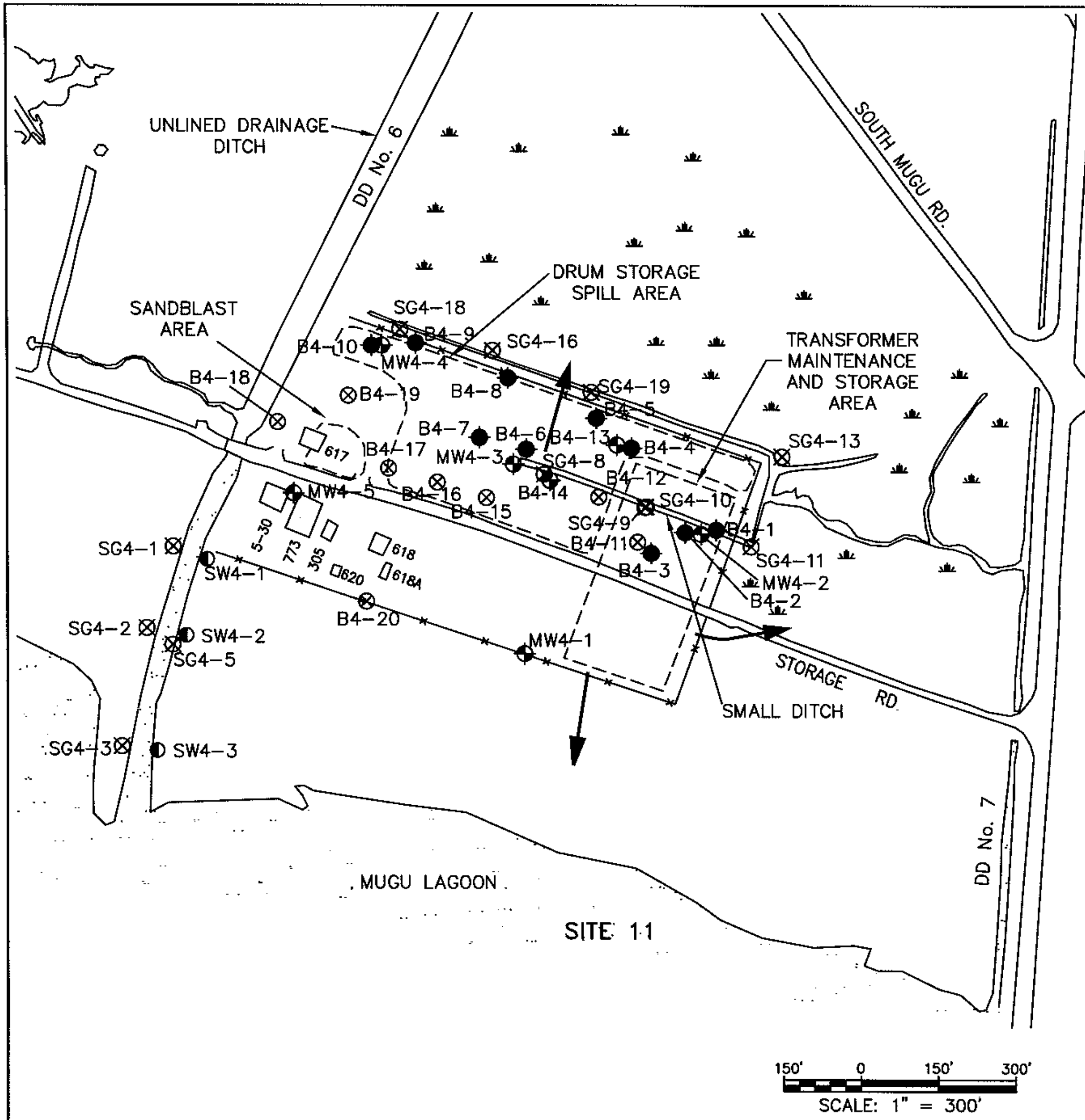
FIGURE 2-25
IRP SITE 4
FORMER PUBLIC WORKS STORAGE YARD SOURCE AREAS

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-25_stor yard source areas.dwg - DWH - 03/30/2004 - G9016.007.04.12.02.04.18



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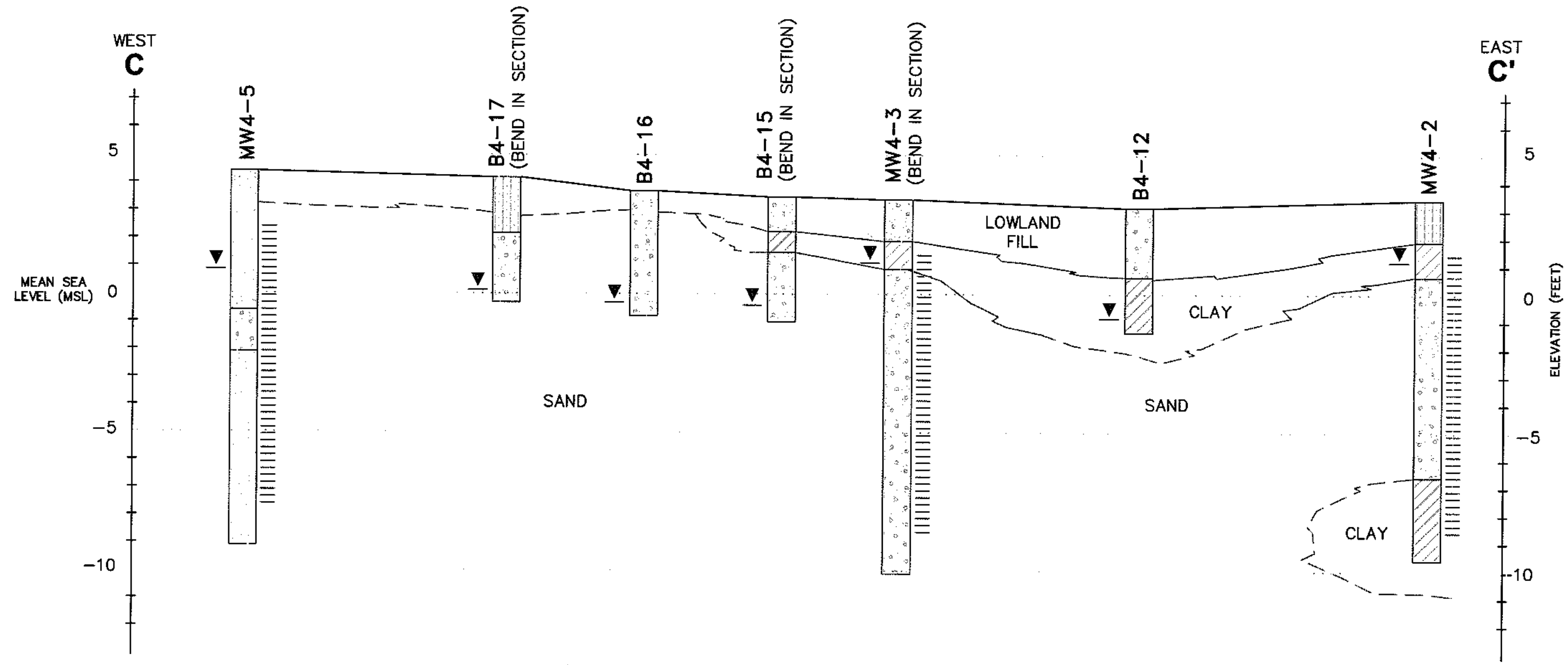
U.S. Navy Southwest Division, NAVFAC, San Diego

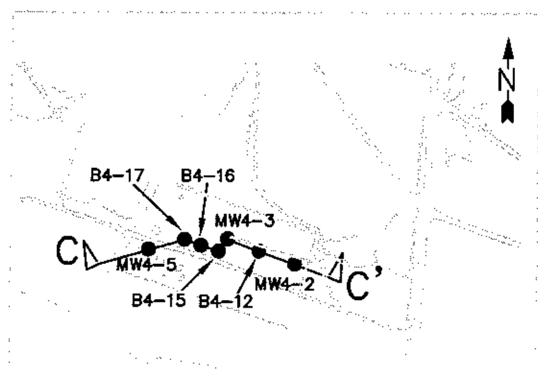
FIGURE 2-26
IRP SITE 4
FORMER PUBLIC WORKS STORAGE YARD
SAMPLE LOCATIONS

Final FS IRP Sites 2, 4, 8, & 9

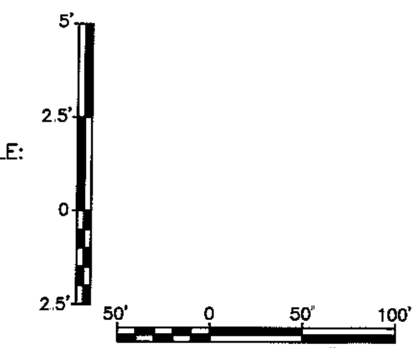


LEGEND

- SW – WELL-GRADED SANDS
- SP – POORLY-GRADED SAND
- SM – SILTY SANDS
- CL – SANDY CLAYS, SILTY CLAYS
- CONTACT
- INFERRED CONTACT
- APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL



SITE 4 LOCATION MAP



VERTICAL SCALE: 1" = 5'

HORIZONTAL SCALE: 1" = 100'

VERTICAL EXAGGERATION IS 20X.

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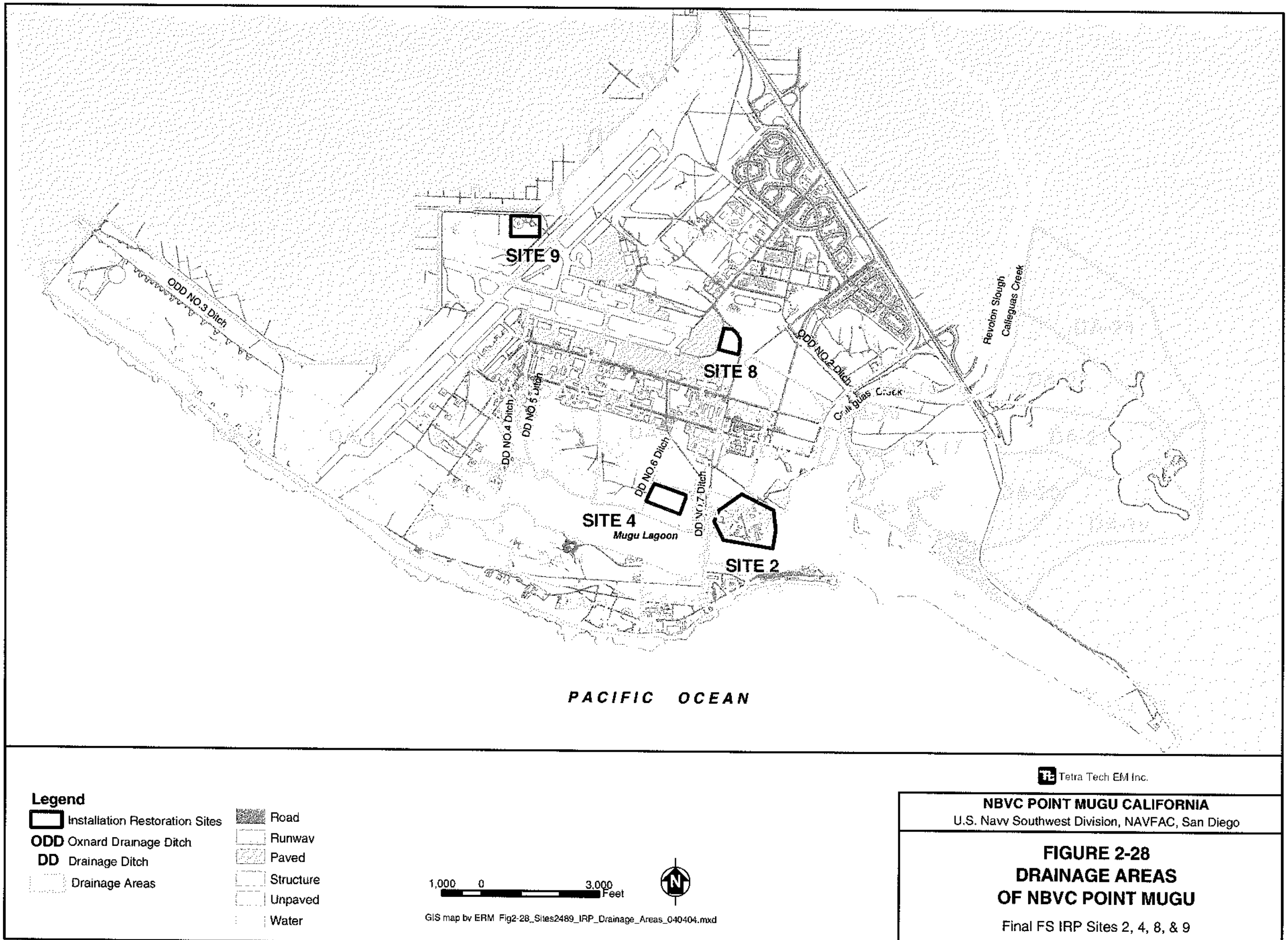
FIGURE 2-27

IRP SITE 4 PUBLIC WORKS STORAGE YARD GEOLOGICAL CROSS-SECTION C-C'

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-27 stor yard x-sect C.dwg - DWH - 03/30/2004 - G9016.007.04 12.02.04 18



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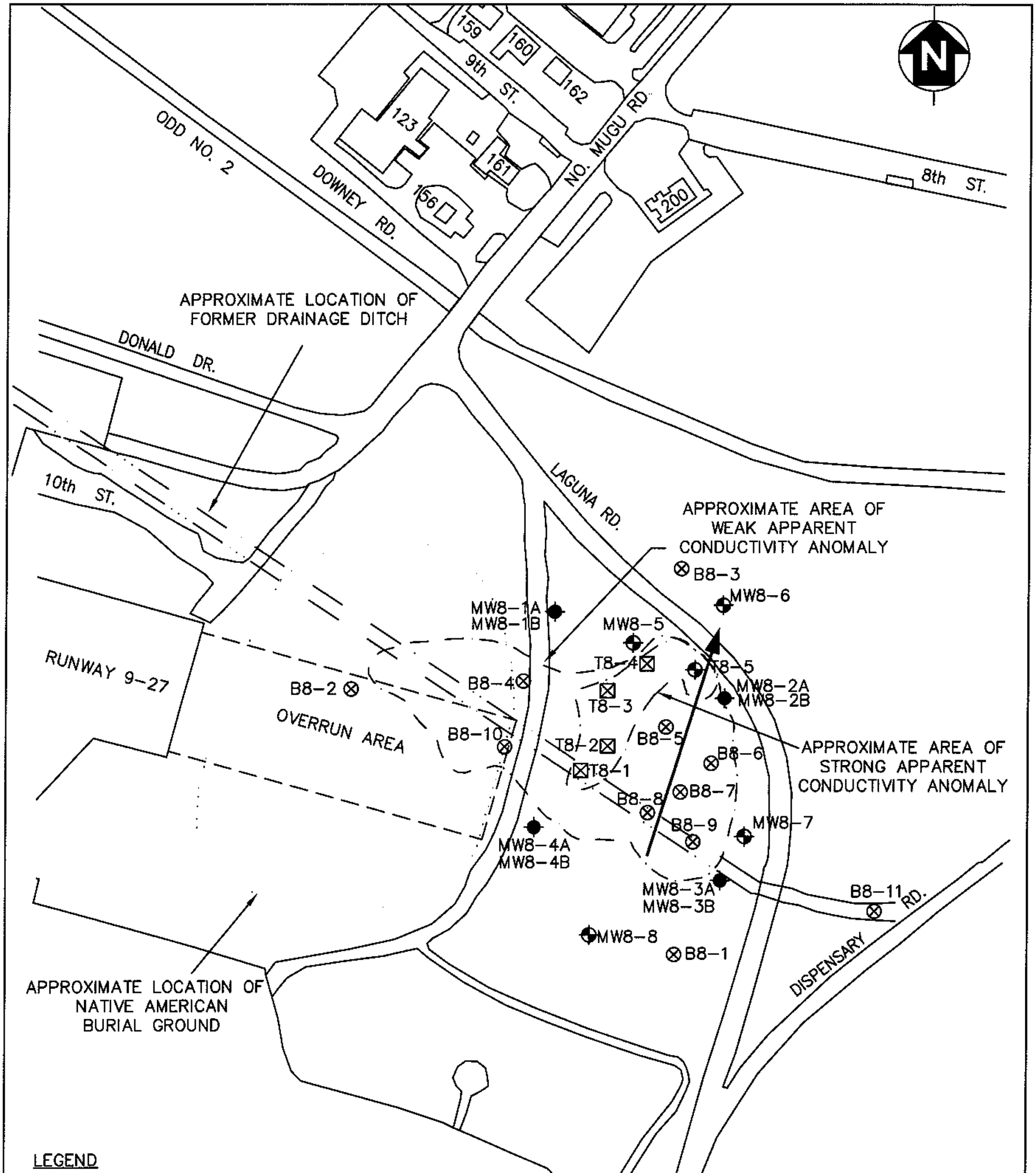
U.S. Navv Southwest Division, NAVFAC, San Diego

FIGURE 2-28
DRAINAGE AREAS
OF NBVC POINT MUGU

Final FS IRP Sites 2, 4, 8, & 9



LEGEND

- RI MONITORING WELL LOCATION
- SI MONITORING WELL LOCATION
- SOIL BORING LOCATION
- TEST PIT
- AVERAGE GROUNDWATER FLOW DIRECTION

150' 0 150' 300'

SCALE: 1" = 300'

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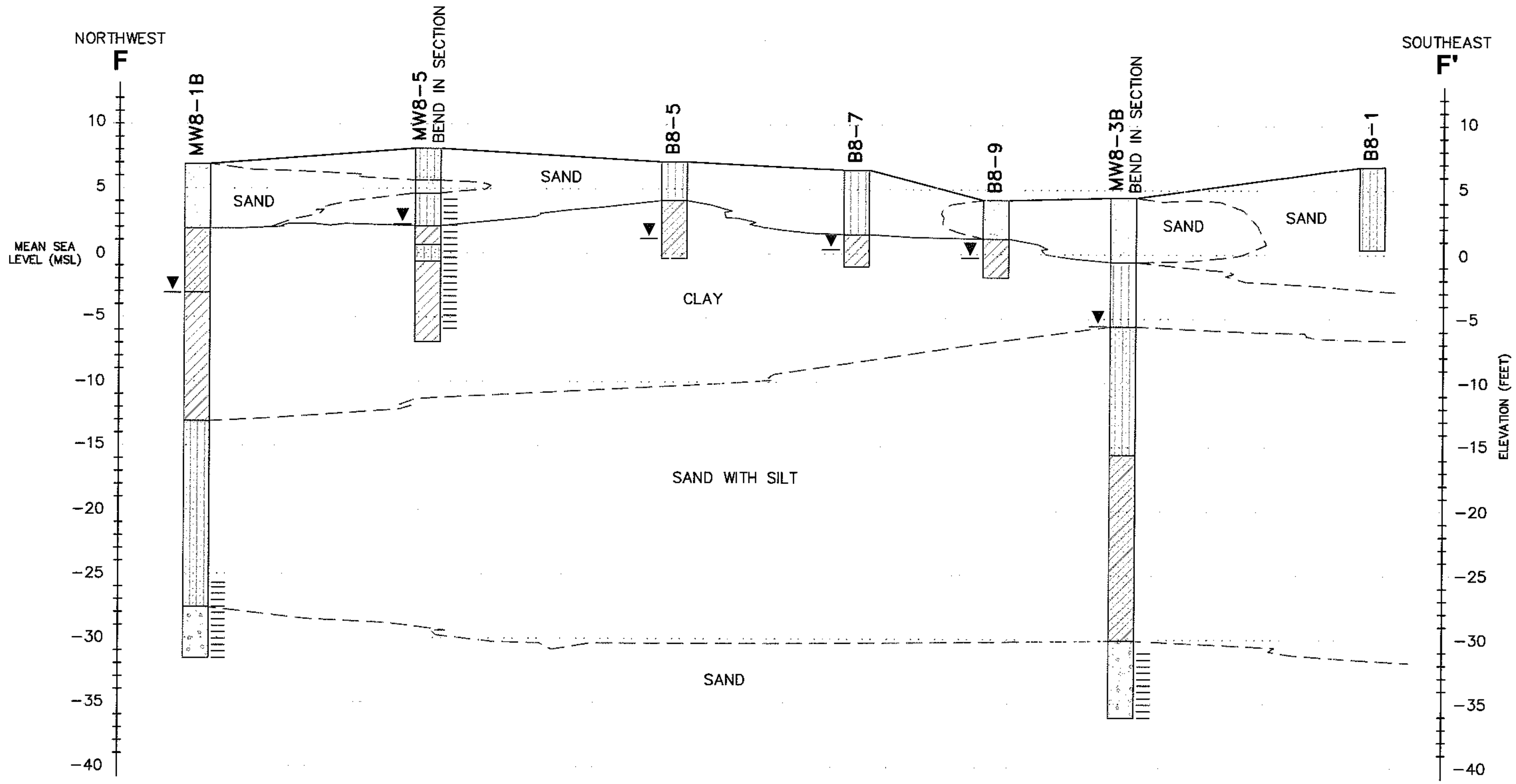
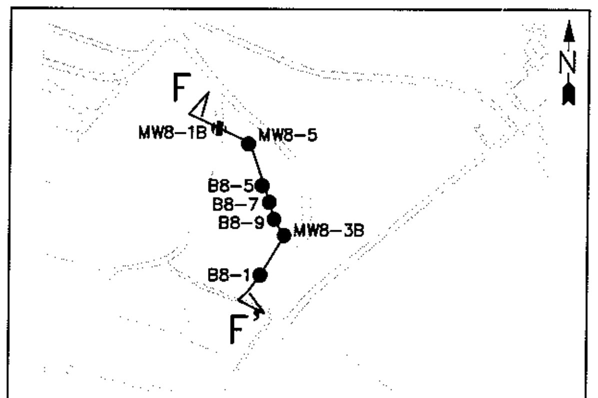
FIGURE 2-29
IRP SITE 8 RUNWAY LANDFILL
SAMPLE LOCATIONS

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-29_landfill samp loc.dwg - DWH - 03/31/2004 - G9016.007.04.12 02 04 18





SITE 8 LOCATION MAP

LEGEND

SW – WELL-GRADED SANDS
SP – POORLY-GRADED SANDS
SM – SILTY SANDS
SC – CLAYEY SANDS
ML – SANDY SILTS, CLAYEY SILTS
CL – SANDY CLAYS, SILTY CLAYS
CONTACT
INFERRED CONTACT
APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
MONITORING WELL SCREENED INTERVAL

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'
VERTICAL EXAGGERATION IS 10X

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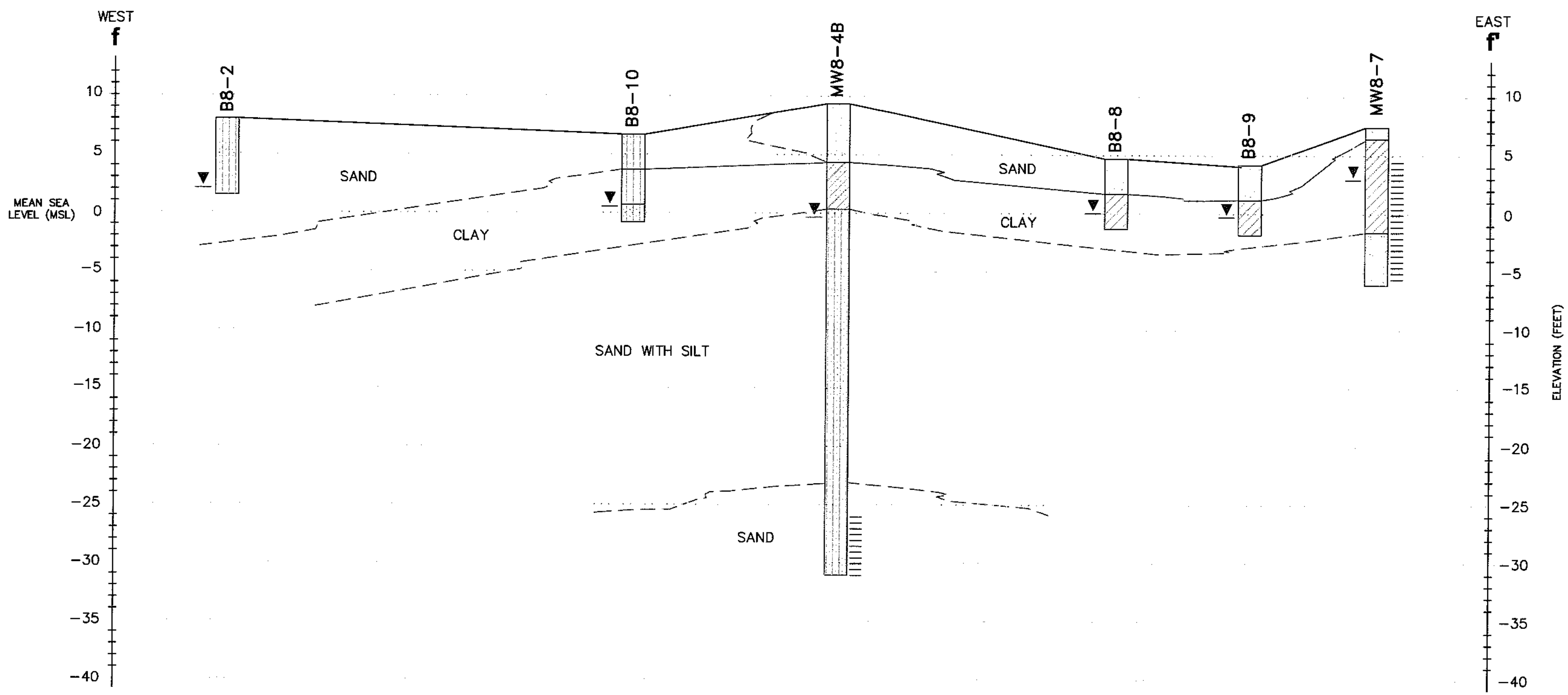
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-30
IRP SITE 8 RUNWAY LANDFILL
GEOLOGICAL CROSS-SECTION F-F'

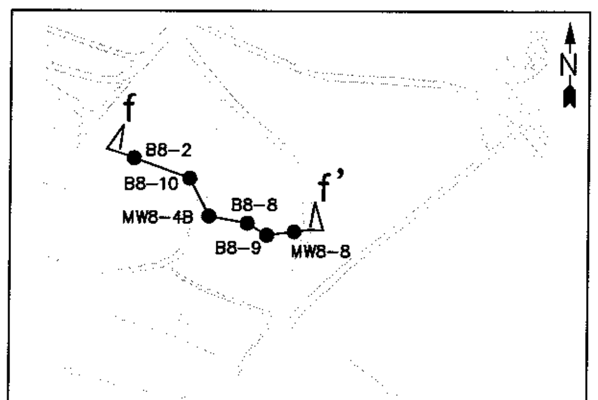
Final FS IRP Sites 2, 4, 8, & 9

Fig 2-30_lanfill x-sect F dwg - DWH - 03/31/2004 - G9016.007.04.12.02.04.18

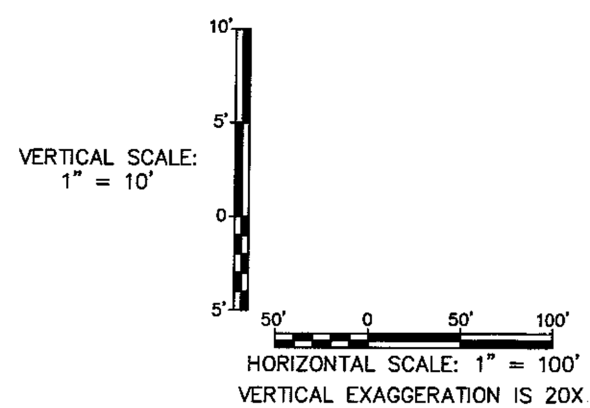


LEGEND

- SP – POORLY-GRADED SANDS
- SM – SILTY SANDS
- SC – CLAYEY SANDS
- ML – SANDY SILTS, CLAYEY SILTS
- CL – SANDY CLAYS, SILTY CLAYS
- CONTACT
- INFERRED CONTACT
- APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL



SITE 8 LOCATION MAP



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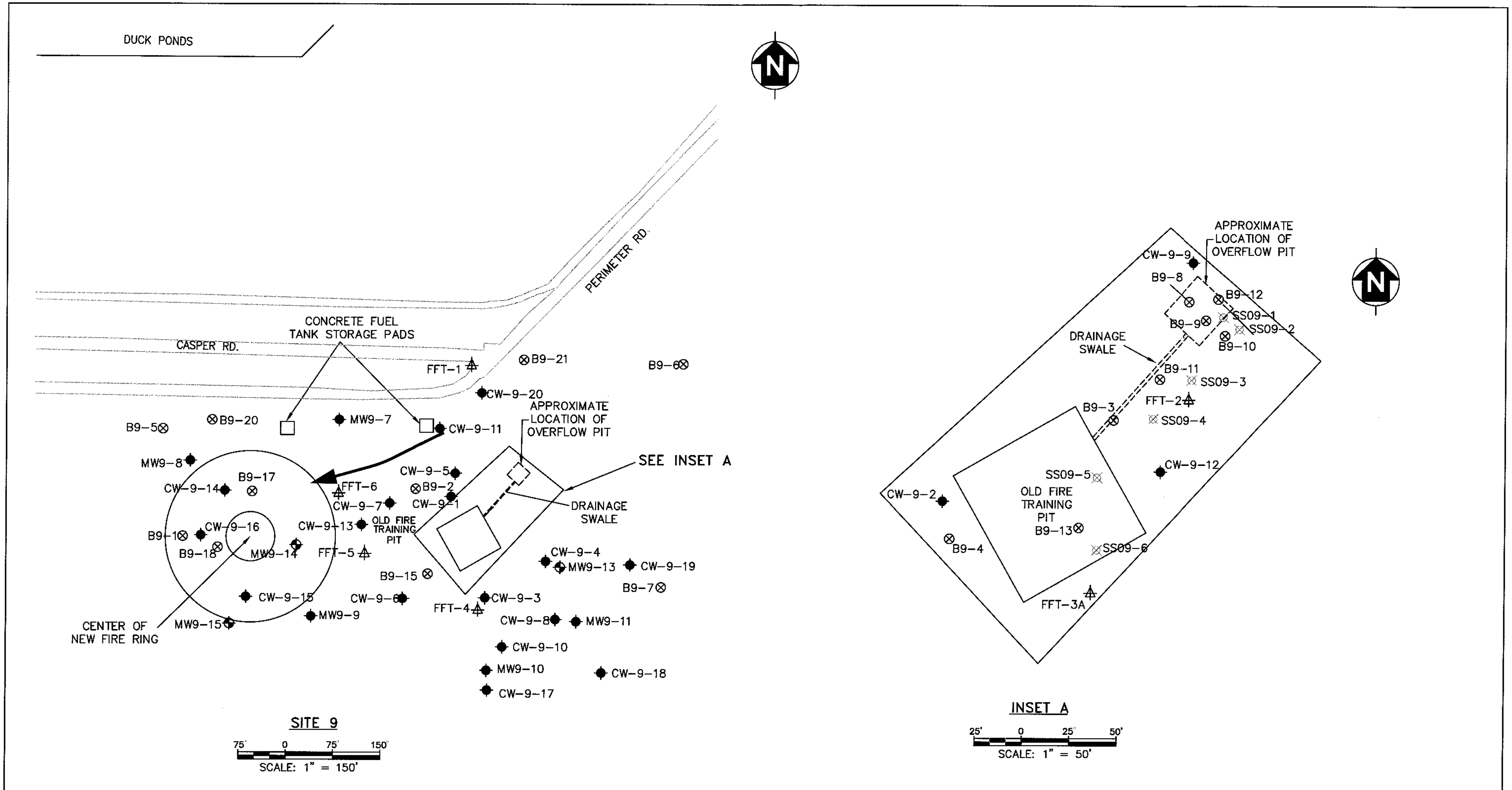
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-31
IRP SITE 8 RUNWAY LANDFILL
GEOLOGICAL CROSS-SECTION f-f'

Final FS IRP Sites 2, 4, 8, & 9

Fig 2-31_landfill x-sect f.dwg - DWH - 03/31/2004 - G9016.007 04 12 02 04 18



LEGEND

- RI MONITORING WELL LOCATION
- SI MONITORING WELL LOCATION
- SOIL BORING LOCATION
- CONFIRMATION STUDY WELL LOCATION
- DIOXIN SAMPLE LOCATION
- AVERAGE GROUNDWATER FLOW DIRECTION

NOTE: SI MONITORING WELL LOCATION ARE APPROXIMATE.

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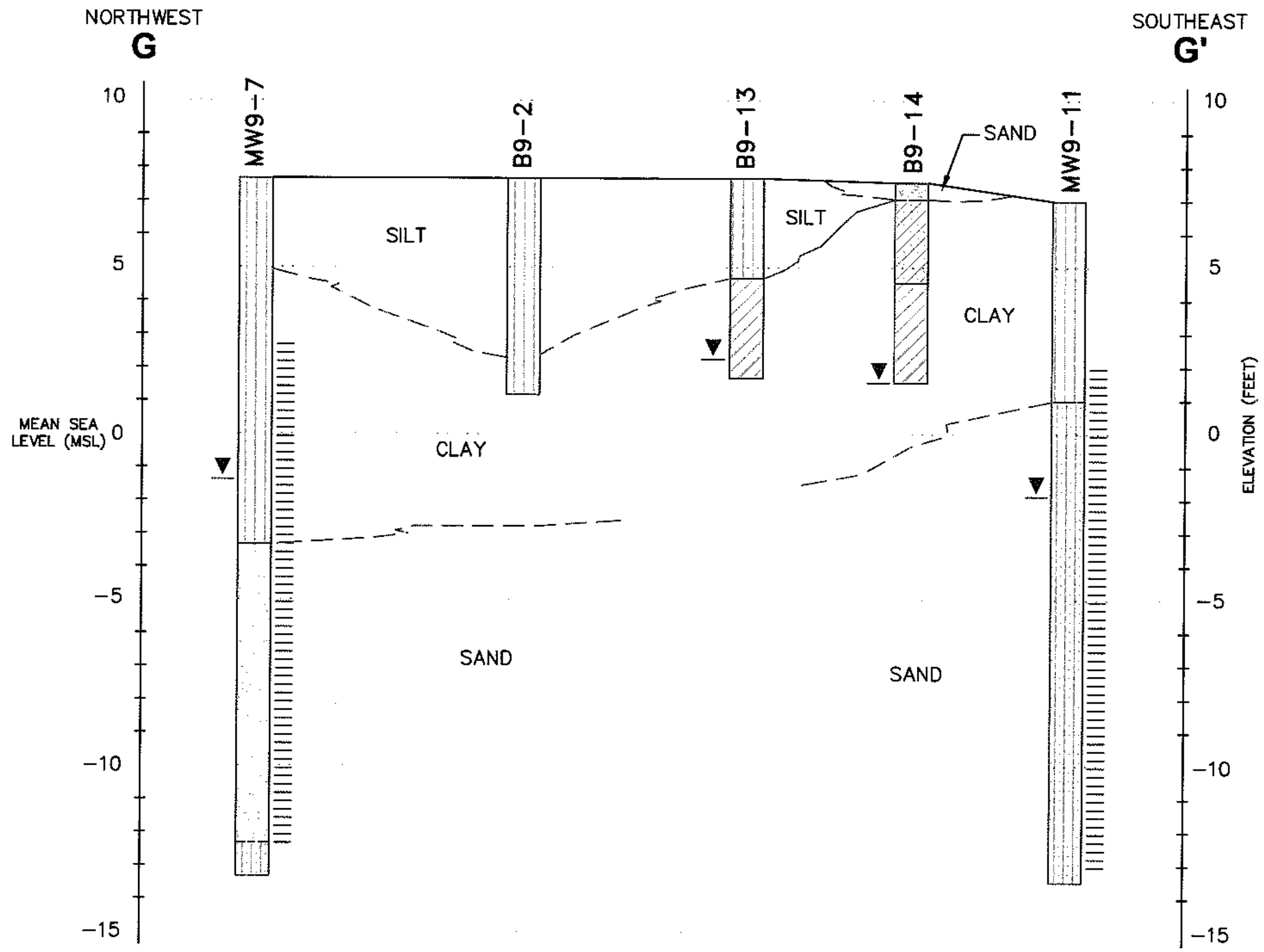
FIGURE 2-32
IRP SITE 9 MAIN BASE FIRE TRAINING AREA SAMPLE LOCATIONS

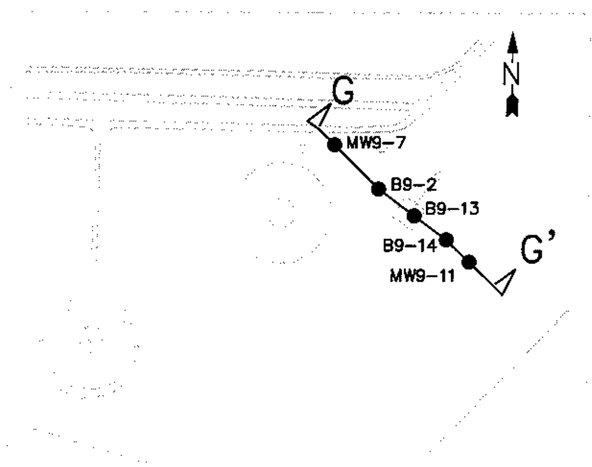
Final FS IRP Sites 2, 4, 8, & 9

Fig 2-32_fire train samp loc.dwg - DWH - 03/31/2004 - G9016.007 04 12 02 04 18

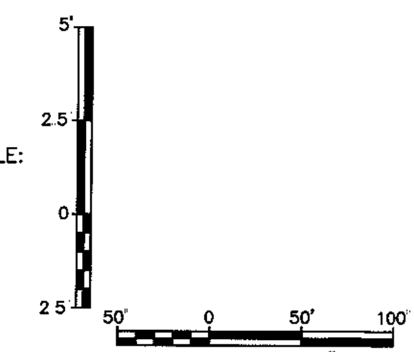


LEGEND

- SW – WELL-GRADED SANDS
- SP – POORLY-GRADED SANDS
- SM – SILTY SANDS
- SC – CLAYEY SANDS
- ML – SANDY SILTS, CLAYEY SILTS
- CL – SANDY CLAYS, SILTY CLAYS
- CONTACT
- INFERRED CONTACT
- APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES
- MONITORING WELL SCREENED INTERVAL



SITE 9 LOCATION MAP



VERTICAL SCALE: 1" = 5'

HORIZONTAL SCALE: 1" = 100'

VERTICAL EXAGGERATION IS 20X.

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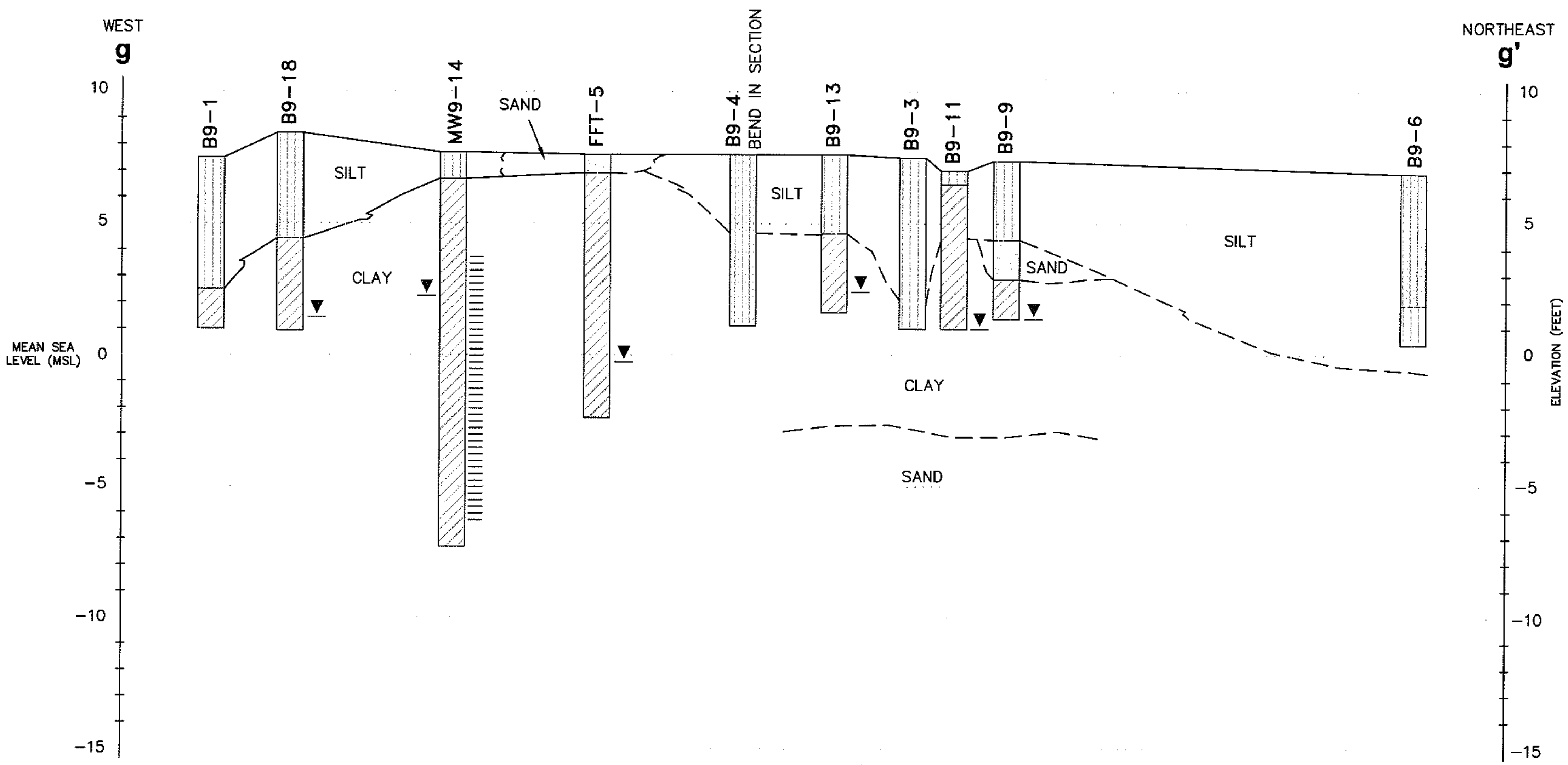
FIGURE 2-33

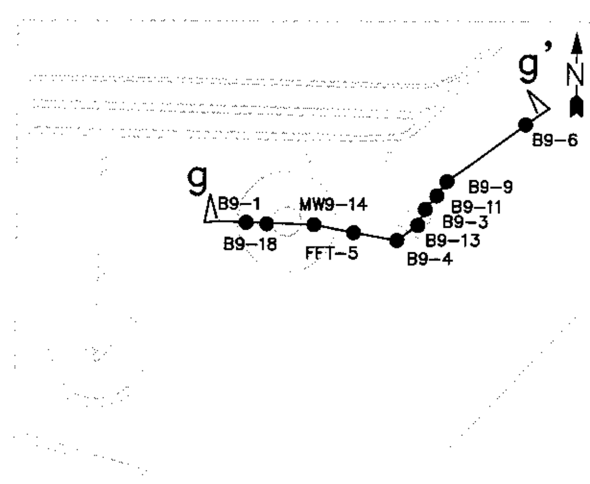
IRP SITE 9 MAIN BASE FIRE TRAINING AREA

GEOLOGICAL CROSS-SECTION G-G'

Draft Final FS IRP Sites 2, 4, 8, & 9

Fig 2-33_fire train x-sect G.dwg - DWH - 03/31/2004 - G9016.007.04 12 02 04 18





SITE 9 LOCATION MAP

LEGEND

SW – WELL-GRADED SANDS

SP – POORLY-GRADED SANDS

SM – SILTY SANDS

ML – SANDY SILTS, CLAYEY SILTS

CL – SANDY CLAYS, SILTY CLAYS

CONTACT

INFERRED CONTACT

APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES

MONITORING WELL SCREENED INTERVAL

VERTICAL SCALE: 1" = 5'

HORIZONTAL SCALE: 1" = 100'

VERTICAL EXAGGERATION IS 40X

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NBVC POINT MUGU, CALIFORNIA

U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-34
IRP SITE 9 MAIN BASE FIRE TRAINING AREA
GEOLOGICAL CROSS-SECTION g-g'

Final FS IRP Sites 2, 4, 8, & 9

TABLES

TABLE 2-1: STRATIGRAPHY OF THE VENTURA BASIN SOUTH OF THE SANTA CLARA RIVER

Feasibility Study for IRP Sites 2, 4, 8, and 9

Age			Description
QUATERNARY	HOLOCENE		ALLUVIUM (Qal). Interbedded layers and lenses of fluvial sand, gravel, cobbles, silt, and clay; 300 to 500 feet thick.
	PLEISTOCENE	UPPER	TERRACE DEPOSITS (Qt). Marine and continental gravel, sand, and clay.
		LOWER	SAN PEDRO FORMATION (Qsp). Marine and fluvial sand, gravel, silt, and clay; 600 to 1,800 feet thick
			SANTA BARBARA FORMATION (PQsb). Marine silt, clay, sand, and gravel; 800 to 2,000 feet thick.
TERTIARY	PLIOCENE		PICO FORMATION (Pp). Marine sandstone and shale with lenses of conglomerate; 0 to 12,000 feet thick.
	MIOCENE		SANTA MARGARITA and MODELO FORMATIONS (Mmsh, Mms). Marine shale and sandstone; 2,000 to 6,500 feet thick.
			VOLCANICS (Mv). Basalt flows and agglomerates with some interbedded sediments; up to 13,000 feet thick.
			TOPANGA FORMATION (Mtp). Marine sandstone, conglomerate, and shale, and associated volcanics; 6,000 to 9,000 feet thick.
			Unknown

Notes:

------- Unconformity

Source: Modified from TtEMI (2000).

IRP	Installation Restoration Program
Mmsh	Miocene
Mtp	Lower to Middle Miocene
Mv	Miocene
PQsb	Lower Pleistocene to Pliocene
Pp	Pliocene
Qal	Quaternary Alluvium
Qt	Quaternary Terraces
Qsp	Lower Pleistocene

TABLE 2-2: HYDROSTRATIGRAPHY OF NBVC
Feasibility Study for IRP Sites 2, 4, 8, and 9

Age			Description of Hydrogeologic Units		Corresponding Stratigraphic Units
QUATERNARY	HOLOCENE		SHALLOW UNCONFINED AQUIFER. Referred to by others as the "semiperched aquifer." Interbedded layers and lenses of sand, gravel silt, and clay; 85 to 135 feet		ALLUVIUM (Qal)
			"CLAY CAP" AQUITARD. Silt, silty clay, and clay with some lenses of sand and gravel; 20 to 45 feet thick.		
	PLEISTOCENE	UPPER	OXNARD AQUIFER. Sand, gravel, and cobbles with lenses of clay, silty clay, and silt; 50 to 100 feet thick	UPPER AQUIFER	
			AQUITARD Silt and clay with lenses of sand and gravel 50 to 100 feet thick.		
			MUGU AQUIFER Sand and gravel with interbedded silt and clay 25 to 250 feet thick.		TERRACE DEPOSITS (Qt)
		LOWER	AQUITARD. Silt and clay with some sand; 50 to 300 feet thick.	LOWER AQUIFER	
			HUENEME AQUIFER (absent at NBVC), FOX CANYON AQUIFER, and GRIMES CANYON AQUIFER. Marine sand and gravel; unknown thickness.		SAN PEDRO FORMATION (Qsp) SANTA BARBARA FORMATION (PQsb)
TERTIARY	PLIOCENE		Undifferentiated.		PICO FORMATION (Pp)

Note:

Source: Modified from TtEMI (2000).

IRP Installation Restoration Program
NBVC Naval Base Ventura County
PQsb Lower Pleistocene to Pliocene
Pp Pliocene
Qal Quaternary Alluvium
Qt Quaternary Terraces
Qsp Lower Pleistocene

TABLE 2-3: HABITAT TYPES PRESENT ON IRP SITES AT NBVC

Feasibility Study for IRP Sites 2, 4, 8, and 9

Habitat Type	IRP Site							
	1	2	4	5	6	8	9	11
Open water/Subtidal			X	X				X
Tidal marsh	X		X	X				X
Intertidal mudflat			X	X				X
Uplands	X	X	X	X	X	X	X	

Notes:

IRP Installation Restoration Program
NBVC Naval Base Ventura County

TABLE 2-4: SPECIAL STATUS SPECIES AT NBVC

Feasibility Study for IRP Sites 2, 4, 8, and 9

Common Name	Scientific Name	Status[a]	Comment
Salt marsh bird's beak	*Cordylanthus maritimus ssp. maritimus*	FE, SE	Tidal marsh on southwest portion of base
California brackish water snail	*Tryonia imitator*	FC2	Mudflat, open water habitats
Globose dune beetle	*Coelus globosus gravida*	FC2	—
Sandy beach tiger beetle	*Cicindela hirticollis gravida*	FC2	—
Saltmarsh skipper	*Panoquina errans*	FC2	—
Tidewater goby	*Eucyclobius newberryi*	FE, CSC	Tidal marsh, open water habitats
Southwestern pond turtle	*Clemmys marmorata pallida*	FC2, CSC	—
California brown pelican	*Pelecanus occidentalis californicus*	FE, SE	Observed feeding in lagoon (Site 11) during surveys
Western least bittern	*Ixobrychus exilis hesperis*	FC2, CSC	Marsh habitats
Harlequin duck	*Histrionicus histrionicus*	FC2, CSC	Inhabits coastal waters in winter
Light-footed clapper rail	*Rallus longiroastris levipes*	FE, SE	Observed at Site 5 in marsh and tidal creek
Western snowy plover	*Charadrius alexandrinus nivosus*	FT, CSC	Mudflat habitat
California least tern	*Sterna antillarum browni*	FE, SE	Open water, tidal creeks
Elegant tern	*Sterna elegons*	FC2, CSC	Open water habitat
American peregrine falcon	*Falco peregrinus anatum*	FE, SE	Multiple habitats, winter resident
Ferruginous hawk	*Buteo regalis*	FC2, CSC	Southwestern U.S. coastal areas in winter
Northern harrier	*Circus cyaneus*	CSC	Upland, marsh habitat
Burrowing owl	*Athene cunicularia*	CSC	Upland habitat
Loggerhead shrike	*Lanium ludovicianus*	FC2, CSC	Upland habitat
Large-billed savannah sparrow	*Passerculus sandwichensis rostratus*	FC2, CSC	Upland, marsh habitat
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*	FC2, SE	Upland, marsh, forages on *Salicornia* and *Atriplex ssp.*
Tricolored blackbird	*Agelaius tricolor*	FC2, CSC	Upland, marsh habitat
Dusky-footed woodrat	*Neotoma fuscipes*	CSC	Upland habitat; observed at Sites 1, 4, and 5 during ecological surveys
Harbor seal	*Phoca vitulina*	MMPA	Observed at Site 11 in lagoon and at lagoon mouth

Notes:

[a] Status as listed in California Department of Fish and Game (1992, 1993). Status verified with California Department of Fish and Game (Cushman 1993) and U S Fish and Wildlife Service (Mitchell 1993).

STATUS:

FE	Federally listed as endangered
FT	Federally listed as threatened
FC2	Category 2 federal candidate for listing
SE	California listed as endangered
CSC	California "Species of Special Concern"
MMPA	Protected under the Marine Mammal Protection Act

Source: TtEMI (2000).

TABLE 2-5: WASTE DISPOSAL SUMMARY FOR IRP SITE 2 OLD SHOPS AREA

Feasibility Study for IRP Sites 2, 4, 8, and 9

Building	Origins of Waste	Waste Type	Estimated Amount	Disposal Period
4-4, 4-5	Repair shop/heavy duty maintenance	Waste oil and solvent	1,000-4,000 gallons	1942-1970
4-15	Tire repair	Waste oil and solvent	500-1,500 gallons	1947-1970
4-29	Automotive maintenance	Waste oil and solvent	500-1,000 gallons	1960-1980
4-30	Automotive maintenance	Waste oil and solvent	250-1,000 gallons	1960-1975
4-32	Automotive maintenance	Waste oil and solvent	250-1,000 gallons	1960-1975
4-35	Grease rack	Waste oil and solvent	300-3,000 gallons	1947-1960
4-Area	Paint shop	Paint waste and thinners	300-1,000 gallons	1942-1945
4-Area	Carpenter shop, Electric shop, Plumbing shop	Waste solvent, thinner, and waste oil	100-1,000 gallons	1942-1945
4-8[a], 4-25	Paint shop	Paint waste and thinners	1,000-3,000 gallons	1946-1962
4-25	Sandblasting	Paint chips and sand	50-1,000 cubic feet	1946-1962
4-30	Battery shop Public works Transportation	Sulfuric acid and lead	5,000-20,000 gallons	1948-1965
402	Battery shop Public works Transportation	Sulfuric acid and lead	5,000-10,000 gallons	1965-1980
4-2, 4-3, 4-7[a], 4-10[a], 4-11[a], 4-31[a]	Public works Maintenance shops	Waste solvent, thinner, paint, and oil	200-1,000 gallons	1946-1954
4-31[a]	Generator shop	Waste oil	2,000-6,000 gallons	1949-1954
4-6	Janitor service	Pesticide rinsate	1,000-10,000 gallons	1948-1962

Notes:

(a) Building could not be located on 1985 base map.
Source: SCS and Landau Associates 1985.

IRP Installation Restoration Program

3.0 NATURE AND EXTENT OF CONTAMINATION AND SUMMARY OF RISK ASSESSMENT – IRP SITES 2, 4, 8, AND 9

The following section summarizes the source characteristics, distribution of contaminants in soil, results of the HHRA in the Phase I RI (TtEMI 2000), results of the ecological risk characterization, and the contaminant and site risks for soil at IRP Sites 2, 4, 8, and 9 at NBVC Point Mugu. Groundwater at IRP Sites 2, 4, 8, and 9 was addressed in the Phase I RI (TtEMI 2000) as well as in the RI for Groundwater (TtEMI 2004). No pathways for direct human exposure to groundwater were identified. Therefore, exposure to contaminants in groundwater was not addressed in the HHRA. Because groundwater can migrate to surface water, however, the ecological risk assessment evaluated the potential exposure of ecological receptors to contaminants in surface water within or adjacent to IRP Sites 2, 4, 8, and 9.

Most of the conclusions in this risk assessment summary are based on the DTSC-approved HHRA performed as part of the Phase I RI (TtEMI 2000). To aid in the interpretation of the risk assessment results, EPA guidance on the role of the risk assessment in supporting risk management decisions is considered. According to the EPA directive Memorandum Regarding the Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions (EPA 1991), if cumulative carcinogenic risk to an individual based on RMEs for both current and future land use is less than 1×10^{-4} and the hazard quotient is less than 1, action is evaluated on a site by site basis.

When action is warranted at a site (that is, risk exceeds 1×10^{-4}), remedial action goals are considered. In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), EPA has defined general remedial goals for sites on the National Priorities List (Title 40 of the CFR Part 300.430). These goals include a target risk range, which is defined as "an excess upperbound lifetime cancer risk to an individual from exposure to site contamination of between 1×10^{-4} and 1×10^{-6}," or between 1 in 10,000 and 1 in 1,000,000.

In general, the EPA directive is used in interpreting the need for remedial action at a site (EPA 1991). Action is not proposed when the risks associated with residential exposure at a site are below 1×10^{-6}; however, site-specific conditions may cause action to be proposed at sites where the risk is below 1×10^{-4}. Consequently, carcinogenic risks within the target risk range of 1×10^{-4} and 1×10^{-6} are discussed in the risk characterization sections of this report. In addition, a COC is identified when the risk for the chemical exceeds 1×10^{-6}, or if the hazard quotient exceeds 1. This information is reviewed to confirm that no site-specific conditions (that is, localized contamination or potentially unidentified sources) warrant further investigation or remediation. Consistent with the EPA directive, this review is documented in a risk management decision by the Navy.

The HHRA results indicate that total cancer risks at IRP Sites 2 and 9 are within the risk range for industrial use sites, and that the hazard index for each site is less than 1. The results of the HHRA are based on industrial worker, construction worker and residential exposure scenarios. The HHRA results also indicate that the total cancer risk at IRP Site 4 is below the NCP-defined "unconditionally acceptable" level of 1×10^{-6} for sites managed as wildlife habitats, and that the chronic toxicity hazard for the site is less than 1. Finally, the HHRA showed that the total cancer risk at IRP Site 8 is also below the NCP-defined "unconditionally acceptable" level for any land use scenario. In addition, the chronic toxicity hazard for the site is less than 1. Deviation from specified land use at NBVC Point Mugu would require re-evaluation of human health risks.

The ecological risk assessment identified no COCs for groundwater at IRP Sites 2, 4, 8, and 9

3.1 IRP SITE 2 – OLD SHOPS AREA

IRP Site 2 was used between 1942 and 1980 for disposal of wastes. During that period, waste from site shops was spread on the surface for disposal. The waste included battery acid, solvents, thinners, paint wastes, pesticide rinsate, and waste oil.

3.1.1 Source Characteristics

The final Phase I RI (TtEMI 2000) estimates that between 1942 and 1980, the following types and quantities of wastes were disposed at IRP Site 2:

- Sulfuric acid and lead – 10,000 to 30,000 gallons
- Waste oil and solvents – 3,200 to 13,500 gallons
- Paint waste and thinners – 1,000 to 3,000 gallons
- Paint chips and sand – 50 to 1,000 cubic feet
- Waste oil – 2,000 to 6,000 gallons
- Pesticide rinsate – 1,000 to 10,000 gallons.

3.1.2 Distribution of Contaminants in Soil and Groundwater

Analytical results from the Phase I RI identified that low levels of contamination are present in the shallow and medium depth soils at IRP Site 2. Although a number of chemicals were detected at the site, most chemicals were detected at very low concentrations and frequencies. Arochlor-1260 is distributed in soil at low levels in two small parts of the site. Figure 3-1 shows the spatial distribution of Arochlor-1260 found in soil at IRP Site 2.

Groundwater sampling at IRP Site 2 during the RI for Groundwater (TtEMI 2004) showed measurable detections of the inorganic contaminants cobalt, copper, lead, mercury, nickel, and zinc. However, inorganic contaminants were measured at low concentrations and were not found on a consistent basis. No organic contaminants were found in groundwater at IRP Site 2 (TtEMI 2004).

3.1.3 Results of the HHRA

The HHRA performed for IRP Site 2 included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). As part of this FS, the HHRA for pathways of concern were reevaluated for Site 2 using the Phase I RI soil data. The backup summary tables for this HHRA are included as Appendix C.

3.1.3.1 Identification of COPCs

COPCs are defined as all chemicals that are potentially site-related and whose data are of sufficient quality for use in the HHRA. The COPCs for the IRP sites were identified through a four-step process. First, preliminary lists of COPCs were developed that included all analytes detected in one or more soil samples at each individual IRP site. Second, metals considered to be essential nutrients and metals detected at concentrations below background levels were removed from the data set. Third, chemicals detected at less than a 5 percent frequency were eliminated as COPCs after conducting a spatial evaluation to determine that the detections were not associated with a source. Finally, if no single sample exceeded the EPA Region IX preliminary remediation goal (PRG), the chemical was eliminated as a COPC. PRGs corresponding to a cancer risk of 1×10^{-7} or a hazard quotient of 0.1 were used to account for potential cumulative risk.

For IRP Site 2, preliminary COPCs identified for soil in the Phase I RI included SVOCs, pesticides/PCBs, and inorganics, including heavy metals. Following the four-step COPC identification process described above, Aroclor-1260 is the only soil COPC evaluated quantitatively in the HHRA.

No COPCs were identified for groundwater at IRP Site 2 during the RI for Groundwater. However, groundwater is evaluated based on recent EPA guidance on evaluating the vapor intrusion to indoor air pathway (EPA 2002). In the new guidance, EPA recommends a tiered approach to evaluate the potential for volatile compounds to migrate into indoor air. The guidance contains target concentrations for chemicals in groundwater which correspond to a cancer risk of 1×10^{-6} or a hazard quotient of 1, based upon conservative modeling. If the groundwater concentrations do not exceed the target concentrations, the pathway is considered incomplete and no additional evaluation is necessary. At IRP Site 2, three VOCs were detected in groundwater. The maximum detected concentrations for these VOCs do not exceed the screening levels presented in EPA's vapor intrusion guidance. Therefore, no further evaluation is necessary for this pathway.

3.1.3.2 Exposure Assessment

The exposure assessment included the identification of potential receptors and exposure pathways, the estimation of chemical concentrations at the point of exposure, and the estimation of contaminant doses. The conceptual model for the IRP Site 2 human health exposure pathway is presented in Figure 3-2. It identifies the possible receptors and exposure pathways at the site.

Neither the Phase I RI (TtEMI 2000) nor the RI for Groundwater (TtEMI 2004) identified any pathways for direct human exposure to groundwater at IRP Site 2.

Potential receptors at IRP Site 2 included current and future industrial users and construction workers. Industrial activity was assumed to occur on site on a daily basis. Periods of construction activity, 6 months to 1 year long, were assumed to occur either during maintenance of existing infrastructure or during new construction. At the request of DTSC, the HHRA also evaluated future child and adult residential receptors.

The exposure routes evaluated included soil ingestion, dermal contact with soil, and inhalation of airborne particles and volatile compounds released from soil. For the residential receptors, ingestion of homegrown produce was also evaluated as an exposure pathway. Because surface water in the area of the site is intermittent after rainfall, and because a direct connection to other surface water bodies is unlikely, surface water was not considered a migration pathway. In addition, direct contact with groundwater was not determined to be an exposure pathway because TDS values are above the maximum values for groundwater to be considered a source for drinking water.

Contaminant concentration data from IRP Site 2 soil samples were used to calculate soil exposure point concentrations (EPC). Air EPCs were calculated from soil EPCs based on a particulate emissions factor. The EPCs then were used to calculate contaminant dose estimates. All IRP Site 2 surface soil data (from 0 to 1 foot bgs) were used to assess the current industrial worker scenario risks and hazards. All IRP Site 2 soil data from 0 to 10 feet bgs were used to assess risks and hazards for the future industrial worker, and residential receptors, under the assumption that soil excavation could result in potential future exposure to subsurface soil.

EPCs were calculated for both average and RME. Average daily doses and lifetime average daily doses associated with current and future exposure pathways were calculated using the EPCs and exposure rate assumptions.

3.1.3.3 Toxicity Assessment

A toxicity assessment provides information on the toxicity of COPCs, including dose response values. Calculation methods and toxicity profiles for COPCs identified at IRP Site 2 are presented in the Phase I RI (TtEMI 2000).

3.1.3.4 Risk Characterization

The risk characterization discusses (1) risks associated with current and future land use scenarios; (2) individual chemicals posing cancer risks greater than 1×10^{-6} or having hazard quotients greater than 1; and (3) site-specific uncertainty issues associated with the risk assessment. COPCs posing a cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1 are identified as COC.

The following table lists the average and RME total cancer risk and HI for each potential receptor at IRP Site 2. For all current and future exposure scenarios, the cancer risk is below EPA's risk management range, with the exception of the RME case for the current industrial worker. For the current industrial worker, the RME cancer risk is within EPA's risk management range as seen in the table below. As discussed in Section 3.1.3.1, the only COPC for IRP Site 2 is Aroclor 1260. Aroclor-1260 therefore accounts for all of the IRP Site 2-related cancer risk and is identified as a COC for the current industrial worker scenario. Noncancer hazards were not calculated for IRP Site 2 because no EPA or State of California reference dose (RfD) values were available for this compound.

		Total Cancer Risk	Total Hazard Index
Current Industrial Worker	Average	6.5×10^{-8}	NA
	RME	1.7×10^{-6}	NA
Future Industrial Worker	Average	2.9×10^{-8}	NA
	RME	3.3×10^{-7}	NA
Short-Term Construction Worker	Average	2.4×10^{-9}	NA
	RME	2.0×10^{-8}	NA
Resident	Average	3.3×10^{-7}	NA
	RME	8.4×10^{-7}	NA

Varying degrees of uncertainty are associated with each stage of an HHRA. The magnitude of uncertainty can significantly influence the results and conclusions of the risk assessment. Typically, when uncertainty is encountered in a risk assessment, the most conservative approach (such as, risk aversion) is selected. This conservative approach was used in the HHRA for IRP Site 2 (see Appendix L of TtEMI 2000).

3.1.4 Results of the Ecological Risk Assessment

An ecological risk assessment, performed for IRP Site 2 as part of the Phase I RI (TtEMI 2000), included a biological characterization to identify habitats at the site, and a scoping assessment to determine potential receptors, exposure pathways, and COPECs as summarized in the following sections.

3.1.4.1 Biological Characterization

IRP Site 2 consists mainly of areas that are either paved or have exposed soil with vegetated areas comprising about 20 percent of the site. The biological characterization at IRP Site 2 identified the primary vegetation to be low-growing shrubs. Four plant species were identified from sampling conducted in the upland area of the site. Mammals observed at IRP Site 2 included California ground squirrels, deer mice, harvest mice, cactus mice, house mice, foxes, coyotes, and feral dogs. Because the site consists of mainly paved areas and exposed soil, the quality of habitat for ecological receptors is low.

3.1.4.2 Scoping Assessment

IRP Site 2 is an industrial area located in an active area of NBVC Point Mugu. The site could support small mammals such as mice, rats, rabbits, and birds; however, there is limited habitat due to the presence of paved areas and exposed soil.

COPECs were determined for soil and groundwater by comparing chemical concentrations with background concentrations and ecological effects criteria using the method described in the Phase I RI (TtEMI 2000). COPECs in soil included VOCs, SVOCs, pesticides, and PCBs. In addition, inorganics (including heavy metals) were detected during the scoping assessment. The results of the Phase I RI concluded that contaminants were detected infrequently or were present at very low concentrations similar to background or below ecological effects criteria, indicating that they are unlikely to pose a risk to terrestrial organisms or to provide a concentrated source of chlorinated organics to Mugu Lagoon.

Groundwater sampling at IRP Site 2 during the RI for Groundwater showed measurable detections of the inorganic contaminants cobalt, copper, lead, mercury, nickel, and zinc. However, these contaminants were measured at low concentrations and were not found on a consistent basis. The RI for Groundwater did not identify any COPECs in groundwater at IRP Site 2 (TtEMI 2004).

Based on the results of the risk assessments conducted to date for IRP Site 2, there is no unacceptable risk to ecological receptors at the site and future reuse as an industrial site will limit potential for exposure in the future.

3.1.5 Summary of IRP Site 2 Contaminants and Risks

This section describes the risks resulting from contaminants in soil and groundwater at IRP Site 2. These risks are based on the results of the HHRA and the ecological risk assessment performed as part of the Phase I RI (TtEMI 2000).

The anticipated land use for IRP Site 2, as designated by NBVC Point Mugu, is industrial in nature, and NBVC Point Mugu will maintain ownership and control of the site within the foreseeable future.

Preliminary human health COPCs in soil at IRP Site 2 include 19 SVOCs, 5 pesticide/PCBs, and 22 inorganics (including heavy metals). Following the COPC identification process, Aroclor-1260 is the only COPC quantitatively evaluated in the HHRA. Human health risks were estimated for current and future industrial workers, short-term construction workers, and adult and child residents. Based on the HHRA, potential human health cancer risks to future industrial workers, short-term construction workers, and adult and child residents are below EPA's risk management range. Cancer risk estimates for the current industrial worker are between 1×10^{-4} and 1×10^{-6}, within the NCP-defined generally acceptable range. Aroclor-1260 was the only COC identified at IRP Site 2 under the industrial and residential exposure scenarios.

Uplands habitats at IRP Site 2 pose little or no risk to ecological receptors. Although a number of COPECs were identified in soils, these chemicals were detected at very low concentrations and at low frequencies. Thus, no soil COCs for ecological receptors were identified at IRP Site 2.

During groundwater sampling at IRP Site 2, measurable detections of the inorganic contaminants cobalt, copper, lead, mercury, nickel, and zinc occurred. However, concentrations were low and did not consistently exceed National Ambient Water Quality Criteria. Therefore, no inorganic contaminants were identified as COPCs or COPECs at the site. No organic contaminants were detected above background in groundwater at IRP Site 2 (TtEMI 2004).

No COPCs or COPECs were identified for groundwater at IRP Site 2 during the Phase I RI (TtEMI 2000) or RI for Groundwater (TtEMI 2004).

3.2 IRP SITE 4 – PUBLIC WORKS STORAGE YARD

IRP Site 4 was used between 1966 and 1970 for disposal of wastes. During that period, transformers were serviced and maintained in the eastern portion of the site. Transformers, as well as waste chemical and oil drums, were stored in the northern and central portion of the site. In 1994, sandblasting was conducted in the western portion of IRP Site 4.

3.2.1 Source Characteristics

The Phase I RI (TtEMI 2000) estimates that between 1966 and 1970, approximately 20 to 40 gallons of PCBs or PCB-contaminated transformer fluid leaked onto the unpaved ground at IRP Site 4. In addition, waste chemicals and oil drums were stored at IRP Site 4. Neither the volume nor content of these drums were identified. However, some drums reportedly contained the following (PRC and JMM 1993):

- Unspecified solvents
- Trichloroethene (TCE)
- Waste oil
- Stoddard solvents
- Paints containing lead
- Paint stripper
- Sludge containing methylene chloride
- Phenols

Sandblasting was conducted to the east of Building 617 in August 1994. Visible sandblasting grit covered about ¼ acre east of Building 617. Sandblasting waste was spread to other parts of the site by wind, vehicle tires, and storm water because the waste was not contained.

3.2.2 Distribution of Contaminants in Soil and Groundwater

As discussed in Section 2.0, a number of chemicals were detected at the site. Most chemicals were detected at very low concentrations and frequencies. High concentrations of Arochlor-1260 were found in the soil at IRP Site 4 (TtEMI 2000). However, because of a removal action in 1997, levels of PCBs have been reduced to below 0.88 mg/kg, which was the remedial action objective for that constituent at the site (OHM 1997).

The Phase I RI (TtEMI 2000) concluded that groundwater at IRP Site 4 contained four inorganic contaminants, copper, lead, nickel, and zinc. However, none of these metals were identified as COPCs or COPECs for IRP Site 4 in the RI for Groundwater (TtEMI 2004). In addition, the RI for Groundwater (TtEMI 2004) did not indicate that these contaminants were detected above screening levels in groundwater at IRP Site 4, nor were any additional contaminants detected at the site during the investigation.

3.2.3 Results of the HHRA

The HHRA performed for IRP Site 4 included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). The backup summary tables for the HHRA are included as Appendix C.

3.2.3.1 Identification of COPCs

For IRP Site 4, preliminary COPCs identified for soil in the Phase I RI included VOCs, SVOCs, pesticides/PCBs, and inorganics, including heavy metals. Following the four-step COPC identification process described in Section 1.1.3.1, soil COPCs evaluated quantitatively in the HHRA were Aroclor-1254, Aroclor-1260, and lead. However, a soil removal action performed in 1997 effectively eliminated all COCs as was identified in confirmation soil samples collected during the removal action (OHM 1997).

No COPCs were identified for groundwater at IRP Site 4 during the RI for Groundwater (TtEMI 2004). Although seven VOCs were detected in groundwater at IRP Site 4, the maximum detected concentrations for these VOCs do not exceed the screening levels presented in EPA's guidance. Therefore, no further evaluation is necessary for this pathway.

3.2.3.2 Exposure Assessment

The exposure assessment included the identification of potential receptors and exposure pathways, the estimation of chemical concentrations at the point of exposure, and the estimation of contaminant doses. The conceptual model for the IRP Site 4 human health exposure pathway is presented Figure 3-3. Neither the Phase I RI (TtEMI 2000) nor the RI for Groundwater (TtEMI 2004) identified any pathways for direct human exposure to groundwater at IRP Site 4.

Potential receptors at IRP Site 4 included current and future wildlife managers. Future residential use of the site was not evaluated because the site is located in the middle of a salt marsh, and the construction of residential homes on the site will not occur. The site has been restored to marshland and is protected as a jurisdictional wetland.

Current base wildlife management activities occur in the Mugu Lagoon and IRP Site 4 area about 40 days per year (PRC and others 1994). More frequent exposure (125 days per year) is expected for the future wildlife manager based on the following assumptions: the site is managed in the future as a wildlife refuge; Mugu Lagoon is managed by the FWS; and, more active wildlife management activities occur (PRC and others 1994).

The exposure routes evaluated included soil ingestion, dermal contact with soil, and inhalation of airborne particles and volatile compounds released from soil. Because surface water in the area of the site is intermittent after rainfall, and because a direct connection to other surface water bodies is unlikely, surface water was not considered a migration pathway. In addition, direct contact with groundwater was not determined to be an exposure pathway, because TDS values are above the maximum values for groundwater to be considered a source for drinking water or to have beneficial use as a municipal water supply.

Contaminant concentration data from IRP Site 4 soil samples were used to calculate soil EPCs. Air EPCs were calculated from soil EPCs based on a particulate emissions factor. The EPCs then were used to calculate contaminant dose estimates. All IRP Site 4 soil data were used to assess current and future wildlife manager scenario risks and hazards.

EPCs were calculated for both average and RMEs. Average daily doses and lifetime average daily doses associated with current and future exposure pathways were calculated using the EPCs and exposure rate assumptions.

3.2.3.3 Toxicity Assessment

A toxicity assessment provides information on the toxicity of COPCs, including dose response values. Calculation methods and toxicity profiles for COPCs identified at IRP Site 4 are presented in the Phase I RI (TtEMI 2000).

3.2.3.4 Risk Characterization

The risk characterization discusses (1) risks associated with current and future land use scenarios; (2) individual chemicals posing cancer risks greater than 1×10^{-6} or having hazard quotients greater than 1; and (3) site-specific uncertainty issues associated with the risk assessment. COPCs posing a cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1 are identified as COCs.

The following table lists the average and RME total cancer risk and HIs for the current and future wildlife management scenarios. For all scenarios, the cancer risk is below EPA's risk management range, and the hazard indices are below the threshold of 1. In addition, the maximum detected concentration for lead (408 mg/kg) does not exceed the EPA Region IX industrial PRG for lead (750 mg/kg). Since the total cancer risks and HIs are below the risk management range, no COCs are identified for IRP Site 4.

Risk Value	Current Wildlife Management		Future Wildlife Management	
	Average	RME	Average	RME
Total Cancer Risk	1.8×10^{-8}	2.0×10^{-7}	5.6×10^{-8}	6.3×10^{-7}
Total Hazard Index	<0.005	<0.005	<0.005	<0.005

3.2.4 Results of the Ecological Risk Assessment

IRP Site 4 currently consists of two sand islands, a restored tidal creek, and a mudflat area. An ecological risk assessment was performed for IRP Site 4 as part of the Phase I RI (TtEMI 2000). The risk assessment included a biological characterization to identify habitats at the site and a scoping assessment to determine potential receptors, exposure pathways, and COPECs. In addition, an assessment of potential ecological risk was conducted during the removal action and construction of wetland habitat at the site (OHM 1997).

3.2.4.1 Biological Characterization

The biological characterization at IRP Site 4 included vegetation, benthic infauna and epifauna, and mammal surveys. Eight plant species were identified from sampling conducted in the tidal marsh habitat. Disturbed upland areas not directly associated with the marsh supported coastal scrub vegetation. Mammals observed at IRP Site 4 included coyote, gray fox, red fox, feral dogs, and dusky-footed woodrat.

3.2.4.2 Scoping Assessment

IRP Site 4 was a public works storage yard. The storage areas of this site supported small mammals such as mice and other receptors such as rabbits and passerine birds. The scoping assessment for IRP Site 4 was conducted prior to the removal action and construction of the sand nest islands. COPECs identified for soil at IRP Site 4 during the Phase I RI included 14 PAHs, PCBs, and lead. Sediment COPECs included carbon disulfide, toluene, five PAHs, several pesticides, and three inorganic chemicals (beryllium, sodium, and vanadium) (TtEMI 2000). Groundwater COPECs included the following metals: copper, lead, nickel, and silver.

Based on the conclusions of the scoping assessment, the Navy completed a predictive assessment for the upland and tidal marsh areas of IRP Site 4 to establish a basis for cleanup levels for PCBs and heavy metals. An exposure assessment was completed for the California clapper rail, least tern, great blue heron, western sandpiper, and peregrine falcon (OHM 1997). Cleanup levels were established for PCBs, arsenic, lead, and copper. The removal action was completed in

1997 and confirmation samples were collected to ensure that the COCs were removed. No ecological COCs were identified for IRP Site 4 after the remediation was completed (OHM 1997) and therefore, IRP Site 4 does not pose an unacceptable risk to ecological receptors.

3.2.5 Summary of IRP Site 4 Contaminants and Risks

This section describes the risks resulting from contaminants in soil and groundwater at IRP Site 4. These risks are based on the results of the HHRA and the ecological risk assessment performed as part of the Phase I RI (TtEMI 2000).

The anticipated land use for IRP Site 4, as designated by NBVC Point Mugu and the COE, is as a jurisdictional wetland. Current and future use of the site by human receptors is limited by the tidal marsh environment and the expected future use of the site as a wildlife area.

Before the removal action, COPCs in soil at IRP Site 4 included nine SVOCs. In addition, Aroclors 1254 and 1260 and arsenic were determined to be COCs for human receptors; and arsenic, copper, and lead were determined to be ecological COCs. However, because of the removal action and site restoration at IRP Site 4, these COCs have been eliminated. Based on the HHRA, potential human health cancer risks to current and future wildlife managers are less than 1×10^{-6}, below EPA's risk management range, for current and future intended uses. Thus, soil COCs were not identified at IRP Site 4.

Naturally elevated TDS concentrations exceed the RWQCB guidance maximum value of 3,000 mg/L. Therefore, the shallow unconfined aquifer beneath IRP Site 4 is considered not a source of drinking water.

No COPCs or COPECs were identified for groundwater at IRP Site 4 during either the Phase I RI (TtEMI 2000) or the RI for Groundwater (TtEMI 2004).

3.3 IRP SITE 8 – RUNWAY LANDFILL

IRP Site 8 was used between 1945 and 1952 for disposal of residential and shop wastes. During that period, wastes were spread on the surface for disposal. The site also was used for trash burning during the time it was operational as a waste disposal area. Upon abandonment, the site was covered with 3 feet of soil (TtEMI 2000).

3.3.1 Source Characteristics

The types and quantities of waste disposed at the site are not well documented (TtEMI 2000). It is assumed that an unspecified number of empty paint cans were disposed at the site. During the Phase I RI, metal and plastic debris also were observed at the site.

3.3.2 Distribution of Contaminants in Soil and Groundwater

Low levels of contamination are present in the shallow-depth soils at IRP Site 8. Although a number of chemicals were detected at the site, most chemicals were detected at very low concentrations and frequencies. The soil samples obtained from IRP Site 8 contained VOCs, SVOCs, pesticide/PCBs, and inorganic chemicals (including heavy metals).

During the Phase I RI (TtEMI 2000) for IRP Site 8, cobalt, copper, lead, mercury, nickel, silver, and zinc were detected in groundwater at above National Ambient Water Quality Standards during at least one quarterly sampling period. In addition to the previously identified contaminants, during the RI for Groundwater (TtEMI 2004), cadmium was detected, although inconsistently, in one monitoring well.

3.3.3 Results of the HHRA

The HHRA performed for IRP Site 8 included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). The backup summary tables for the HHRA are included as Appendix C.

3.3.3.1 Identification of COPCs

For IRP Site 8, preliminary COPCs identified for soil in the Phase I RI included VOCs, SVOCs, pesticides/PCBs, and inorganics, including heavy metals. Following the four-step COPC identification process described in Section 1.1.3.1, 4,4′-dichlorodiphenyldichloroethane (DDD) is the only soil COPC evaluated quantitatively in the HHRA.

The COPCs for groundwater identified in the RI for Groundwater (TtEMI 2004) are nickel and silver. Although three VOCs were detected in groundwater at IRP Site 4, the maximum detected concentrations for these VOCs do not exceed the screening levels presented in EPA's guidance. Therefore, no further evaluation is necessary for this pathway.

3.3.3.2 Exposure Assessment

The exposure assessment included the identification of potential receptors and exposure pathways, the estimation of chemical concentrations at the point of exposure, and the estimation of contaminant doses. The conceptual model for the IRP Site 8 human health exposure pathway is presented in Figure 3-4. Neither the Phase I RI (TtEMI 2000) nor the RI for Groundwater (TtEMI 2004) identified any pathways for direct human exposure to groundwater at IRP Site 8.

Potential receptors at IRP Site 8 included current and future industrial users and construction workers. Industrial activity was assumed to occur on site on a daily basis. Periods of construction activity, lasting from 6 months to 1 year, were assumed to occur either during maintenance of existing infrastructure or during new construction. At the request of DTSC, the HHRA also evaluated future child and adult residential receptors.

The exposure routes evaluated included soil ingestion, dermal contact with soil, and inhalation of airborne particles and volatile compounds released from soil. For the residential receptors, ingestion of homegrown produce was also evaluated as an exposure pathway. Because surface water in the area of the site is intermittent after rainfall, and because a direct connection to other surface water bodies is unlikely, surface water was not considered a migration pathway. In addition, groundwater was not determined to be an exposure pathway because TDS values are above the maximum values for groundwater to be considered a source for drinking water or to have beneficial use as a municipal water supply.

Contaminant concentration data from IRP Site 8 soil samples were used to calculate soil EPCs. Air EPCs were calculated from soil EPCs based on a particulate emissions factor. The EPCs then were used to calculate contaminant dose estimates. All IRP Site 8 surface soil data (from 0 to 1 foot bgs) was used to assess the current industrial worker scenario risks and hazards. All IRP Site 8 soil data from 0 to 10 feet bgs were used to assess risks and hazards for the construction worker, future residential worker, and residential receptors, under the assumption that soil excavation could result in potential future exposure to subsurface soil.

EPCs were calculated for both average and RME exposure scenarios. Average daily doses and lifetime average daily doses associated with current and future exposure pathways were calculated using the EPCs and exposure rate assumptions.

3.3.3.3 Toxicity Assessment

A toxicity assessment provides information on the toxicity of COPCs, including dose response values. Calculation methods and toxicity profiles for COPCs identified at IRP Site 2 are presented in the Phase I RI (TtEMI 2000).

3.3.3.4 Risk Characterization

The risk characterization discusses (1) risks associated with current and future land use scenarios; (2) individual chemicals posing cancer risks greater than 1×10^{-6} or having hazard quotients greater than 1; and (3) site-specific uncertainty issues associated with the risk assessment. COPCs posing a cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1 are identified as COCs.

The following table lists the average and RME total cancer risk for each potential receptor at IRP Site 8. As discussed in Section 1.3.3.1, the only COPC for IRP Site 8 is DDD. Noncancer hazards were not calculated for IRP Site 8 because no EPA or State of California RfDs were available for these compounds. For all exposure scenarios, the cancer risk is below EPAs risk management range, and the hazard indices are below the threshold of 1. Since the total cancer risks and hazard indices are below the risk management range, no COCs are identified for IRP Site 8.

		Total Cancer Risk
Current Industrial Worker	Average	1.4×10^{-10}
	RME	1.9×10^{-9}
Future Industrial Worker	Average	2.2×10^{-10}
	RME	3.0×10^{-9}
Short-Term Construction Worker	Average	1.8×10^{-11}
	RME	2.7×10^{-10}
Resident	Average	3.8×10^{-9}
	RME	1.5×10^{-8}

3.3.4 Results of the Ecological Risk Assessment

IRP Site 8 is primarily a grassy area of approximately 4 acres. An ecological risk assessment, performed for IRP Site 8 as part of the Phase I RI (TtEMI 2000), included a biological characterization to identify habitats at the site, and a scoping assessment to determine potential receptors, exposure pathways, and ecological COPCs.

3.3.4.1 Biological Characterization

IRP Site 8 is a grassy area at the end of Runway 9-27 that is mowed regularly. The flora at IRP Site 8 is mostly low-growing shrubs, grasses, and herbs. This active maintenance discourages more suitable habitat from becoming established at the site. Twelve plant species were identified from sampling conducted in the central upland area of the site. Mammals were not observed at IRP Site 8

3.3.4.2 Scoping Assessment

The site could support small mammals such as mice, rats, rabbits, and birds.

COPECs were determined for soil and groundwater at IRP Site 8 using the method described in the Phase I RI (Section 4.5 of TtEMI 2000). COPECs in soil include toluene, PAHs, and DDT and its degradation products. In addition, inorganic chemicals (including heavy metals) were detected during the scoping assessment. However, these contaminants were detected infrequently or were present at very low concentrations below ecological effects criteria, indicating that they are unlikely to pose a risk to terrestrial organisms or to provide a concentrated source of chlorinated organics to Mugu Lagoon.

Because most contaminants were detected at very low concentrations, had low frequency of detection, concentrations were below ecological effects criteria, and were frequently consistent with natural or anthropogenic background levels, no ecological COCs for soil were identified for IRP Site 8.

The COPECs for groundwater identified in the Phase I RI (TtEMI 2000) include copper, mercury, silver, and phosphorus. Those identified in the RI for Groundwater (TtEMI 2004) are nickel and silver. The results of fate and transport modeling of nickel showed that it would take more than 1,000 years for nickel from IRP Site 8 to exceed its screening criterion in groundwater adjacent to ODD No. 2, the surface water receptor. Further, although the potential exists for nickel in groundwater to contribute to concentrations in surface water, nickel is not likely to be bioavailable or to cause significant effects to ecological receptors (TtEMI 2004). Data were insufficient to model silver.

3.3.5 Summary of IRP Site 8 Contaminants and Risks

This section describes the risks due to contaminants in soil and groundwater at IRP Site 8. These risks are based on the results of the HHRA and the ecological risk assessment performed as part of the Phase I RI (TtEMI 2000).

The anticipated land use for IRP Site 8, as designated by NBVC Point Mugu, is industrial in nature, and NBVC Point Mugu will maintain ownership and control of the site within the foreseeable future.

Preliminary human health COPCs in soil at IRP Site 8 include 2 VOCs, 18 SVOCs, 6 pesticide/PCBs, and 24 inorganics (including heavy metals). Following the COPC identification process, DDD is the only COPC quantitatively evaluated in the HHRA. Human health risks were estimated for current and future industrial workers, short-term construction workers, and adult and child residents. Based on the HHRA, potential human health cancer risks for all receptors are less than 1×10^{-6}, below EPA's risk management range, for current and future intended uses. Thus, soil COCs were not identified at IRP Site 8 under any scenario.

Upland habitats at IRP Site 8 pose little or no risk to ecological receptors. Although a number of ecological COPCs were identified in soil during the Phase I RI, these chemicals were detected at very low concentrations below ecological effects criteria and at low frequencies. Thus, no soil COCs for ecological receptors were identified at IRP Site 8.

No COPCs or COPECs were identified for groundwater at IRP Site 8 during either the Phase I RI (TtEMI 2000) or the RI for Groundwater (TtEMI 2004).

Based on the results of the ecological risk assessment, IRP Site 8 does not pose an unacceptable risk to ecological receptors and continued mowing of the site will discourage more suitable wildlife habitat from becoming established at the site.

3.4 IRP Site 9 – Main Base Fire Training Area

IRP Site 9 was used for fire-training exercises once or twice a week from the late 1950s to 1984. Firefighting training exercises consisted of burning jet fuel and waste oil that were poured into a pit. The fires then were extinguished using water and firefighting chemicals. Any excess fuel, water, or chemicals overflowed the berm, and then flowed down an unlined drainage swale and into an unlined overflow pit located northeast of the old fire pit. The excess fuel and wastewater entering the overflow pit either evaporated or infiltrated the soil. In 1984, the Ventura County Environmental Health Department closed operations at the old fire pit, citing environmental concerns (TtEMI 2000).

3.4.1 Source Characteristics

The Phase I RI (TtEMI 2000) estimated that between the late 1950s and 1978, the following types and quantities of wastes were burned at IRP Site 9:

- Fuel and waste oil – 325,000 gallons.

It is estimated that 10 percent of the fuel did not fully burn (SCS and Landau Associates 1985). An estimated 90 percent of the fuel used for the exercises was reportedly JP-4 or JP-5 jet fuel contaminated by water or other fuels. Most of the waste oils probably were derived from vehicles and engines at NBVC Point Mugu. Waste oils used may have included paint thinner, alcohol, PD-680 solvent, hydraulic fluid, transmission fluid, transformer fluid (reportedly containing PCBs), carbon tetrachloride, and dry-cleaning solvent (PRC and JMM 1993). Figure 3-5 shows the source areas at IRP Site 9.

3.4.2 Distribution of Contaminants in Soil and Groundwater

Figure 3-6 shows the spatial distribution of contaminants found in soil at IRP Site 9. Most of the contaminants at IRP Site 9 are centered on the new fire ring and the old fire training pit and associated drainage swale and overflow pit. The horizontal and vertical extent of contamination is limited because of the small area of the site and the containment provided by the berm surrounding the pits. Dioxins and furans were detected in soil at the old fire-training pit.

The inorganic contaminants detected above National Ambient Water Quality Criteria in groundwater at IRP Site 9 are copper, mercury, nickel, silver, and zinc (TtEMI 2000). These contaminants were detected in three monitoring wells installed on the site. The groundwater contaminants at IRP Site 9 that were identified in the RI for Groundwater (TtEMI 2004) are cobalt, copper, molybdenum, nickel, and zinc.

3.4.3 Results of the HHRA

The HHRA performed for IRP Site 9 included the identification of COPCs, an exposure assessment, a toxicity assessment, and risk characterization. The methods used in the HHRA are described in detail in the Phase I RI (TtEMI 2000). The backup summary tables for the HHRA are included as Appendix C.

3.4.3.1 Identification of COPCs

For IRP Site 9, preliminary COPCs identified for soil in the Phase I RI included VOCs, SVOCs, pesticides/PCBs, dioxins and furans, and inorganics, including heavy metals. Following the four-step COPC identification process described in Section 1.1.3.1, COPCs quantitatively evaluated in the HHRA were dichlorodiphenyldichloroethene (DDE), DDT, Aroclor-1260, and all detected congeners of dioxins and furans.

No COPCs were identified for groundwater at IRP Site 9 during the RI for Groundwater (TtEMI 2004). Although two VOCs were detected in groundwater at IRP Site 9, the maximum detected concentrations for these VOCs do not exceed the screening levels presented in EPA's vapor intrusion guidance. Therefore, no further evaluation is necessary for this pathway.

3.4.3.2 Exposure Assessment

The exposure assessment included the identification of potential receptors and exposure pathways, the estimation of chemical concentrations at the point of exposure, and the estimation of contaminant doses. The conceptual model for the IRP Site 9 human health exposure pathway is presented in Figure 3-7. Neither the Phase I RI (TtEMI 2000) nor the RI for Groundwater (TtEMI 2004) identified any pathways for direct human exposure to groundwater at IRP Site 9.

Potential receptors at IRP Site 9 included current and future industrial users and construction workers. Currently, industrial activity at IRP Site 9 consists of occasional use of the site as a main base fire-training area. Fire-training exercises are assumed to take place twice a month for 2 hours each time, equivalent to an exposure frequency of 6 days per year (PRC and others 1994). However, for consistency with other sites, the default industrial worker was evaluated at IRP Site 9, assuming an exposure frequency of 250 day per year. At the request of DTSC, the HHRA also evaluated future child and adult residential receptors.

Exposure routes evaluated for these scenarios include soil ingestion, dermal contact with soil, and inhalation of volatile and particulate air emissions from soil. For the residential receptors, ingestion of homegrown produce was also evaluated as an exposure pathway. The HHRA also evaluated future child and adult residential receptors, based upon future residential land use.

Contaminant concentration data from IRP Site 9 soil samples were used to calculate soil EPCs. Air EPCs were calculated from soil EPCs based on a particulate emissions factor. The EPCs were then used to calculate contaminant dose estimates. All IRP Site 9 surface soil data (from 0 to 1 foot bgs) were used to assess the current industrial worker scenario risks and hazards. All IRP Site 9 soil data from 0 to 10 feet bgs were used to assess risks and hazards for the construction worker, future construction worker, and residential receptors, under the assumption that soil excavation could result in potential future exposure to subsurface soil.

EPCs were calculated for both average and RME exposure scenarios. Average daily doses and lifetime average daily doses associated with current and future exposure pathways were calculated using the EPCs and exposure rate assumptions.

3.4.3.3 Toxicity Assessment

A toxicity assessment provides information on the toxicity of COPCs, including dose-response values. Calculation methods and toxicity profiles for the COPCs identified at IRP Site 9 are presented in the Phase I RI (TtEMI 2000).

3.4.3.4 Risk Characterization

The risk characterization discusses (1) risks associated with current and future land use scenarios; (2) individual chemicals posing cancer risks greater than 1×10^{-6} or having hazard quotients greater than 1; and (3) site-specific uncertainty issues associated with the risk assessment. COPCs posing a cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1 are identified as COCs.

The following table lists the average and RME total cancer risk and HIs for each potential receptor at IRP Site 9. For the construction worker, the average and RME cancer risks are below EPA's risk management range at both sub-areas. For the current and future industrial worker and the adult and child resident, the average and RME cancer risks are within EPA's risk management range. For all receptors and exposure scenarios, the hazard indices are below 1.

		Total Cancer Risk	Total Hazard Index
Current Industrial Worker	Average	1.1×10^{-6}	<0.005
	RME	1.6×10^{-5}	0.02
Future Industrial Worker	Average	1.0×10^{-6}	<0.005
	RME	1.1×10^{-5}	<0.005
Sub-Area 9-1 Short-Term Construction Worker	Average	2.1×10^{-9}	<0.005
	RME	6.0×10^{-8}	0.02
Sub-Area 9-2 Short-Term Construction Worker	Average	5.2×10^{-9}	<0.005
	RME	6.6×10^{-8}	<0.005
Resident	Average	2.2×10^{-5}	<0.005
	RME	4.9×10^{-5}	<0.005

For the current industrial worker, four COCs are identified as contributing to a cancer risk of 1×10^{-6} or greater under the RME scenario. These COCs and their chemical-specific cancer risks are DDT (1.2×10^{-6}), Aroclor-1260 (6.0×10^{-6}), 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (3.1×10^{-6}), and 1,2,3,7,8-pentachlorodibenzofuran (3.1×10^{-6}).

For the future industrial worker, two COCs are identified as contributing to a cancer risk of 1 × 10-6 or greater under the RME scenario. These COCs and their chemical-specific cancer risks are 2,3,7,8-TCDD (4.1×10^{-6}) and 1,2,3,7,8-pentachlorodibenzofuran (3.1×10^{-6}).

For the future adult and child resident, nine COCs are identified as contributing to a cancer risk of 1×10^{-6} or greater under the RME scenario. These COCs and their chemical-specific cancer risks are Aroclor-1260 (1.4×10^{-6}), 1,2,3,4,6,7,8-heptachlorodibenzodioxin (3.4×10^{-6}), 1,2,3,6,7,8-hexachlorodibenzodioxin (3.4×10^{-6}), 1,2,3,6,7,8-hexachlorodibenzfuran (2.4×10^{-6}), 1,2,3,7,8-pentachlorodibenzofuran (1.4×10^{-5}), 1,2,3,7,8,9-hexachlorodibenzofuran (1.9×10^{-6}), 2,3,7,8-TCDD (1.9×10^{-5}), 2,3,7,8-tetrachlorodibenzofuran (1.4×10^{-6}), and octachloro-dibenzodioxin (1.4×10^{-6}).

3.4.4 Results of the Ecological Risk Assessment

An ecological risk assessment performed for IRP Site 9 as part of the Phase I RI (TtEMI 2000) included a biological characterization to identify habitats at the site, and a scoping assessment to determine potential receptors, exposure pathways, and ecological COPCs.

3.4.4.1 Biological Characterization

The biological characterization of IRP Site 9 is based on the vegetation and mammal surveys described in the Phase I RI (TtEMI 2000). IRP Site 9 is predominantly grasses and perennial herbs. Nine different plant species were identified in the central portion of the site during the Phase I RI. Approximately 33 percent of the site is bare ground. The dominant species is Mediterranean barley (*Hordeum marinum ssp. gussoneanum*), with a cover value of 50 percent. Other dominant species include Australian saltbush (*Atriplex semibaccata*) and barley (*Hordeum brachyantherum*). Mammals observed at IRP Site 9 included deer mice, California ground squirrels, and desert cottontail rabbits; also observed were coyote scat, and opossum tracks.

3.4.4.2 Scoping Assessment

IRP Site 9 is an industrial area located in an active area of NBVC Point Mugu. It is composed largely of pavement and exposed dirt. The site could support small mammals such as mice, rabbits, and passerine birds.

COPECs were determined for soils at IRP Site 9 using the method described in the Phase I RI (Section 4.5 of TtEMI 2000). These COPECs included chrysene, Aroclor 1260, and DDT and its degradation products. All were present at low concentrations either below ecological effects criteria or consistent with natural or anthropogenic background levels. Because most contaminants were detected at very low concentrations below ecological effects criteria, had low frequency of detection, and were frequently consistent with natural or anthropogenic background levels, no ecological COCs were identified for soil at IRP Site 9.

The RI for Groundwater (TtEMI 2004) identified no COPECs for groundwater at IRP Site 9; however, cobalt, copper, molybdenum, nickel, and zinc were detected and were screened for fate and transport modeling. Sufficient data were available to bound the groundwater plume in the downgradient direction for molybdenum and cobalt only. The results showed that concentrations of molybdenum in groundwater adjacent to ODD No. 3, the ecological receptor, would not exceed its screening criterion for about 100 years and that concentrations of cobalt in groundwater adjacent to ODD No. 3 would not exceed its screening criterion for several hundred years.

Based on the results of the ecological risk assessment, no unacceptable risk to ecological receptors exists at the site. In addition, the current site conditions (pavement and bare ground) prohibit more suitable ecological habitat from becoming established at the site. The presence of pavement at the site eliminates potential exposure pathways for ecological receptors.

3.4.5 Summary of IRP Site 9 Contaminants and Risks

This section describes the risks resulting from contaminants in soil and groundwater at IRP Site 9. These risks are based on the results of the HHRA and the ecological risk assessment performed as part of the Phase I RI (TtEMI 2000).

As described in Section 2.0, the anticipated land use for IRP Site 9, as designated by NBVC Point Mugu, is industrial in nature, and NBVC Point Mugu will maintain ownership and control of the site within the foreseeable future.

Preliminary human health COPCs in soil at IRP Site 9 include 3 VOCs, 21 SVOCs, 7 pesticide/PCBs, 23 inorganics (including heavy metals), and 9 dioxins and furans. Following the COPC identification process, DDE, DDT, Aroclor-1260, and all the dioxins and furans are the COPCs quantitatively evaluated in the HHRA. Human health risks were estimated for current and future industrial workers, short-term construction workers, and adult and child residents. Based on the HHRA, potential human health cancer risks for short-term construction workers are below EPA's risk management range. Cancer risk estimates for the current and future industrial worker and adult and child residents are between 1×10^{-4} and 1×10^{-6}, within the NCP-defined generally acceptable range.

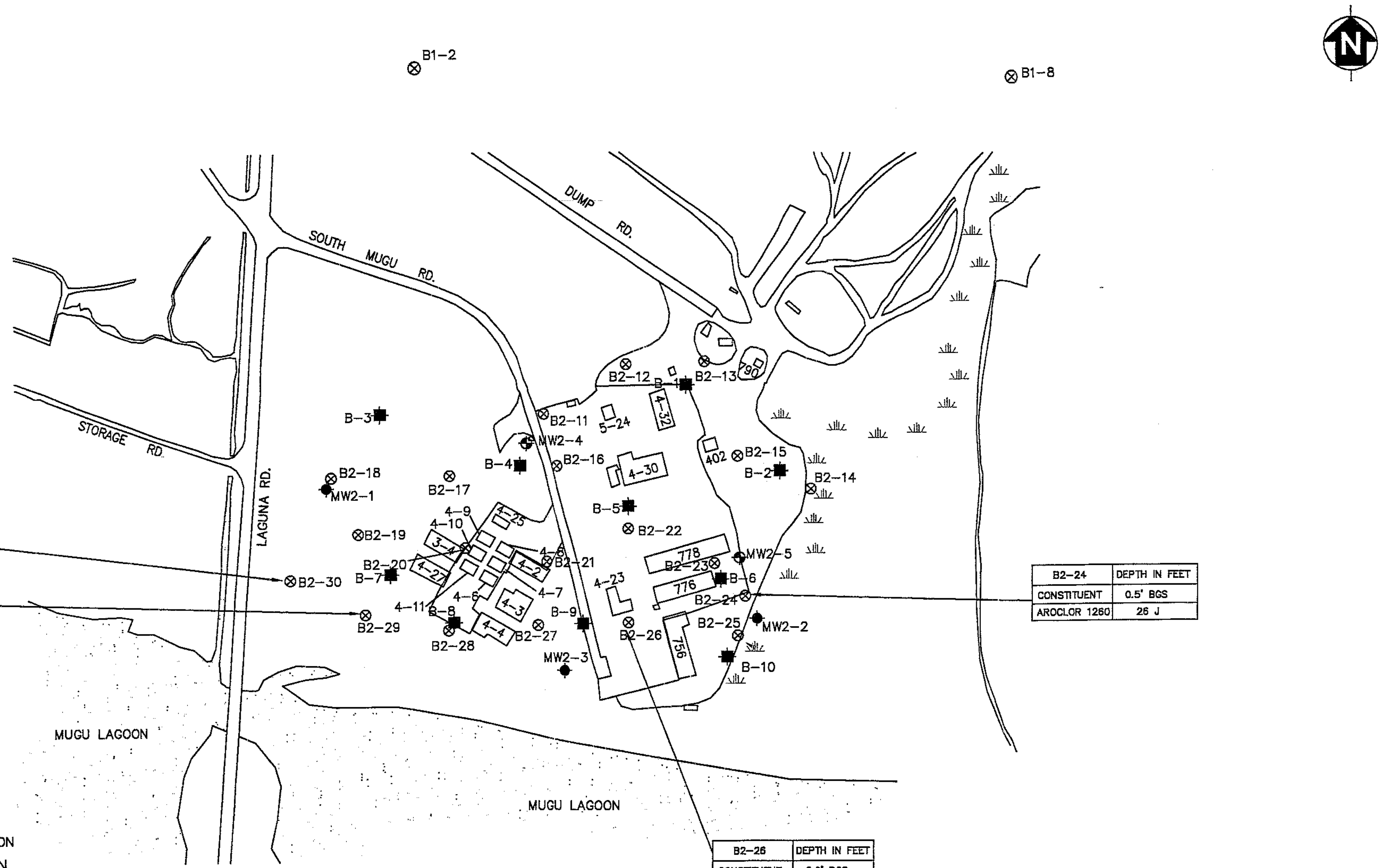
For the current industrial worker, four COCs are identified as contributing to a cancer risk of 1×10^{-6} or greater under the RME scenario. These COCs and their chemical-specific cancer risks are DDT (1.2×10^{-6}), Aroclor-1260 (6.0×10^{-6}), 2,3,7,8-TCDD (3.1×10^{-6}), and 1,2,3,7,8-pentachlorodibenzofuran (3.1×10^{-6}). For the future industrial worker, two COCs are identified under the RME scenario. These COCs and their chemical-specific cancer risks are 2,3,7,8-TCDD (4.1×10^{-6}) and 1,2,3,7,8-pentachlorodibenzofuran (3.1×10^{-6}).

For the future adult and child resident, nine COCs are identified as contributing to a cancer risk of 1×10^{-6} or greater under the RME scenario. These COCs and their chemical-specific cancer risks are Aroclor-1260 (1.4×10^{-6}), 1,2,3,4,6,7,8-heptachlorodibenzodioxin (3.4×10^{-6}), 1,2,3,6,7,8-hexachlorodibenzodioxin (3.4×10^{-6}), 1,2,3,6,7,8-hexachlorodibenzfuran (2.4×10^{-6}), 1,2,3,7,8-pentachlorodibenzofuran (1.4×10^{-5}), 1,2,3,7,8,9-hexachlorodibenzofuran (1.9×10^{-6}), 2,3,7,8-TCDD (1.9×10^{-5}), 2,3,7,8-tetrachlorodibenzofuran (1.4×10^{-6}), and octachlorodibenzodioxin (1.4×10^{-6}).

Uplands habitats at IRP Site 9 pose little or no risk to ecological receptors. Although a number of ecological COPCs were identified in soil during the Phase I RI, these chemicals were detected at very low concentrations and at low frequencies. Thus, no soil COCs for ecological receptors were identified at IRP Site 9.

No COPCs or COPECs were identified for groundwater at IRP Site 9 during either the Phase I RI (TtEMI 2000) or the RI for Groundwater (TtEMI 2004).

FIGURES



B2-30	DEPTH IN FEET
CONSTITUENT	0.0' BGS
AROCLOR 1260	100 J

B2-29	DEPTH IN FEET
CONSTITUENT	0.0' BGS
AROCLOR 1260	20 J

B2-24	DEPTH IN FEET
CONSTITUENT	0.5' BGS
AROCLOR 1260	26 J

B2-26	DEPTH IN FEET
CONSTITUENT	0.0' BGS
AROCLOR 1260	23 J

LEGEND

- RI MONITORING WELL LOCATION
- RI SOIL BORING LOCATION
- SI MONITORING WELL LOCATION
- SI SOIL BORING LOCATION
- SOIL BORING LOCATION

U UNDETECTED
J DETECTED, BUT IS AN ESTIMATED QUANTITY
UJ UNDETECTED, BUT IS AN ESTIMATED QUANTITY
MARSH AREA
NOTE: SI LOCATIONS ARE APPROXIMATE
UNITS = mg/kg (milligrams per kilogram)

150' 0 150' 300'
SCALE: 1" = 300'

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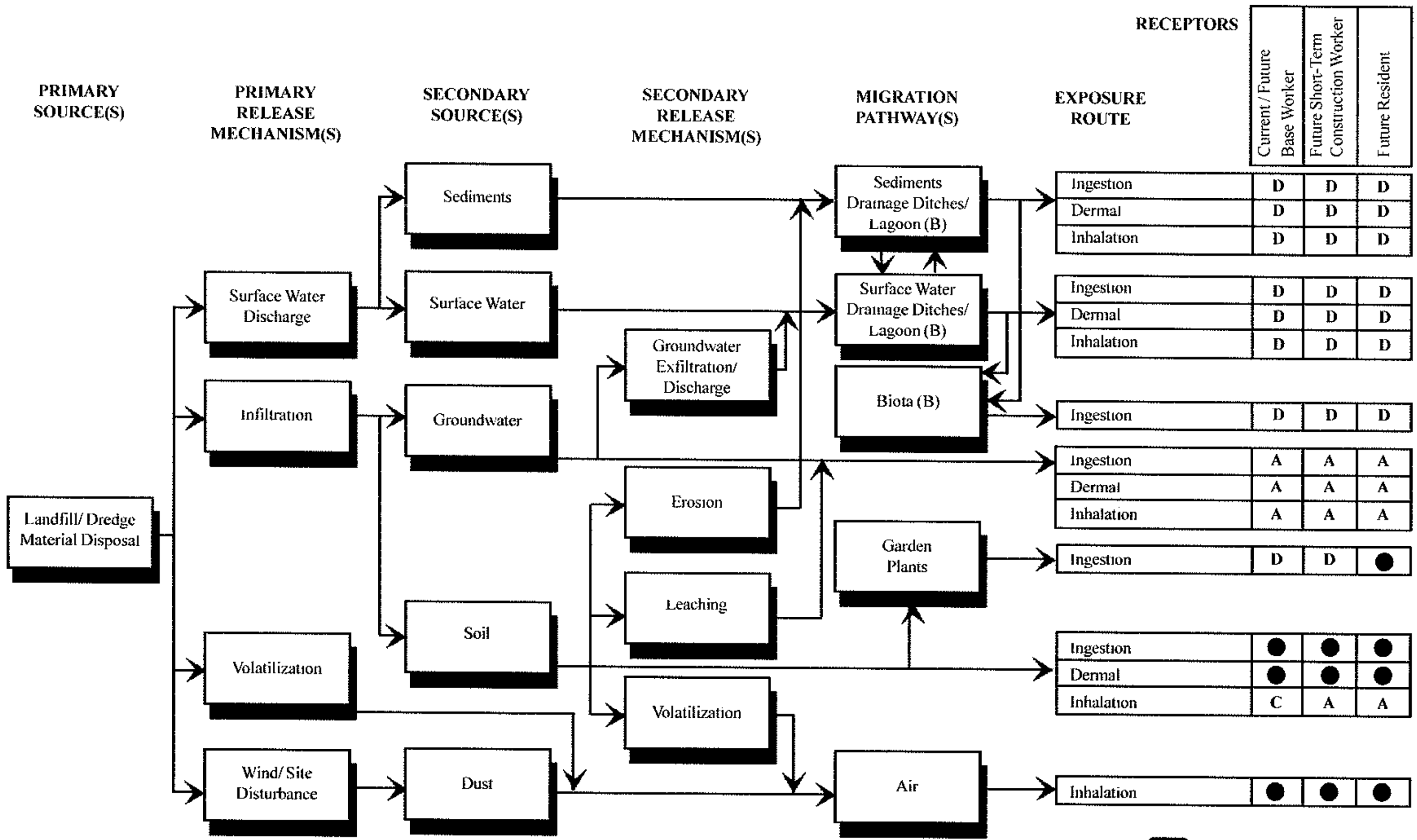
FIGURE 3-1
DISTRIBUTION OF SOIL CONTAMINANT AROCLOR 1260 AT IRP SITE 2

Draft Final FS IRP Sites 2, 4, 8, & 9

Fig 3-1_aroclor dist.dwg - DWH - 09/14/2004 - G9016.007.04.12.02.04 18



A Not a complete pathway.

B Sediment pathways and potentail site impacts to surface water and biota assessed under Site 11, Mugu Lagoon.

C Inhalation of soil is evaluated under the air pathway.

D Not assessed for these media / receptors under Site 2 or 11 (not an applicable pathway).

● Pathways to be evaluated.

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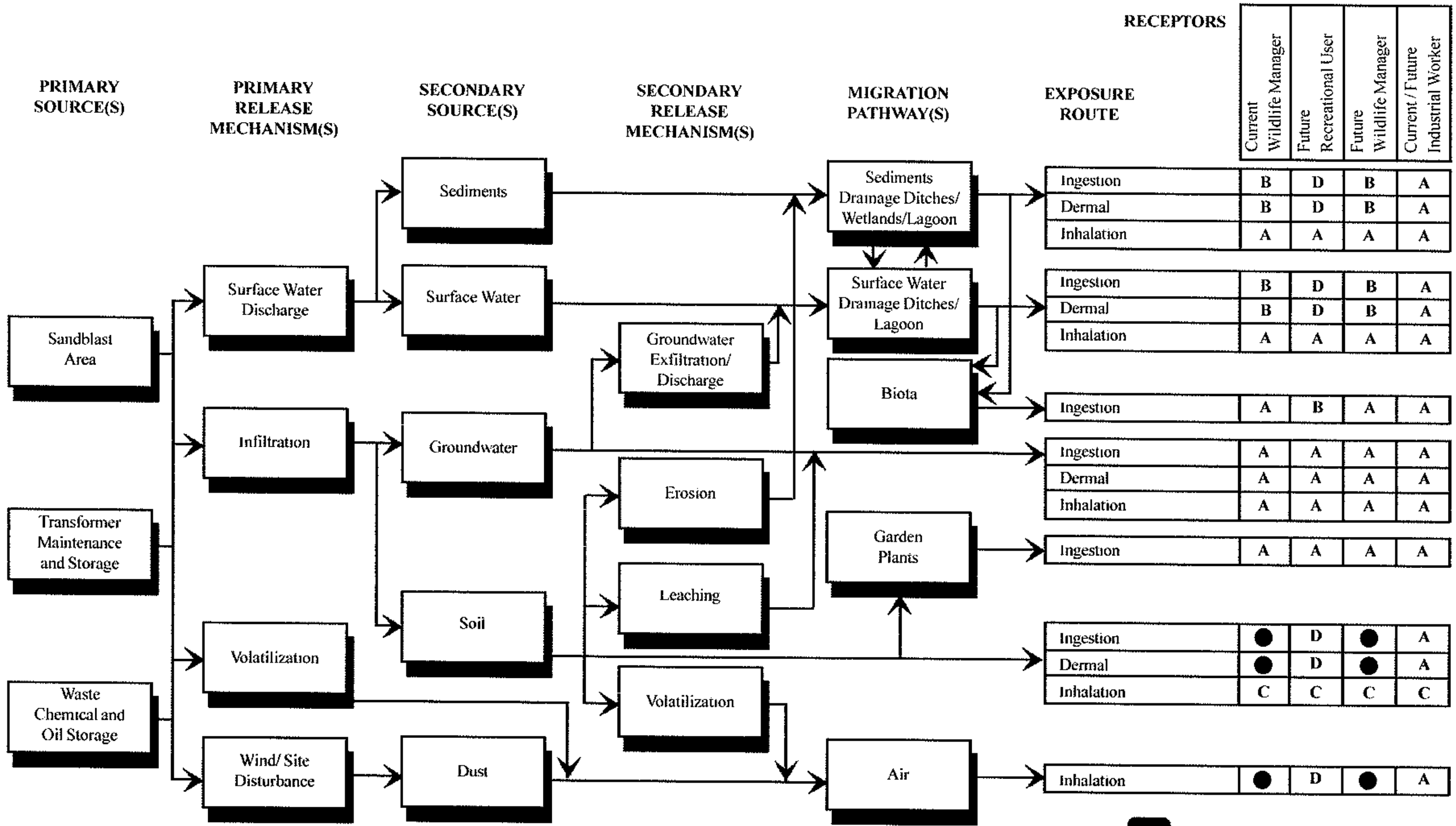
FIGURE 3-2
IRP SITE 2 CONCEPTUAL MODEL FOR HUMAN HEALTH EXPOSURE PATHWAYS

Final FS IRP Sites 2, 4, 8, & 9



A Not a complete pathway.

B Sediment, surface water and biota pathways assessed under Site 11, Mugu Lagoon.

C Inhalation of soil is evaluated under the air pathway.

D Risks not quantified. Refer to Wildlife Management Scenario for Risk Evaluation.

● Pathways to be evaluated.

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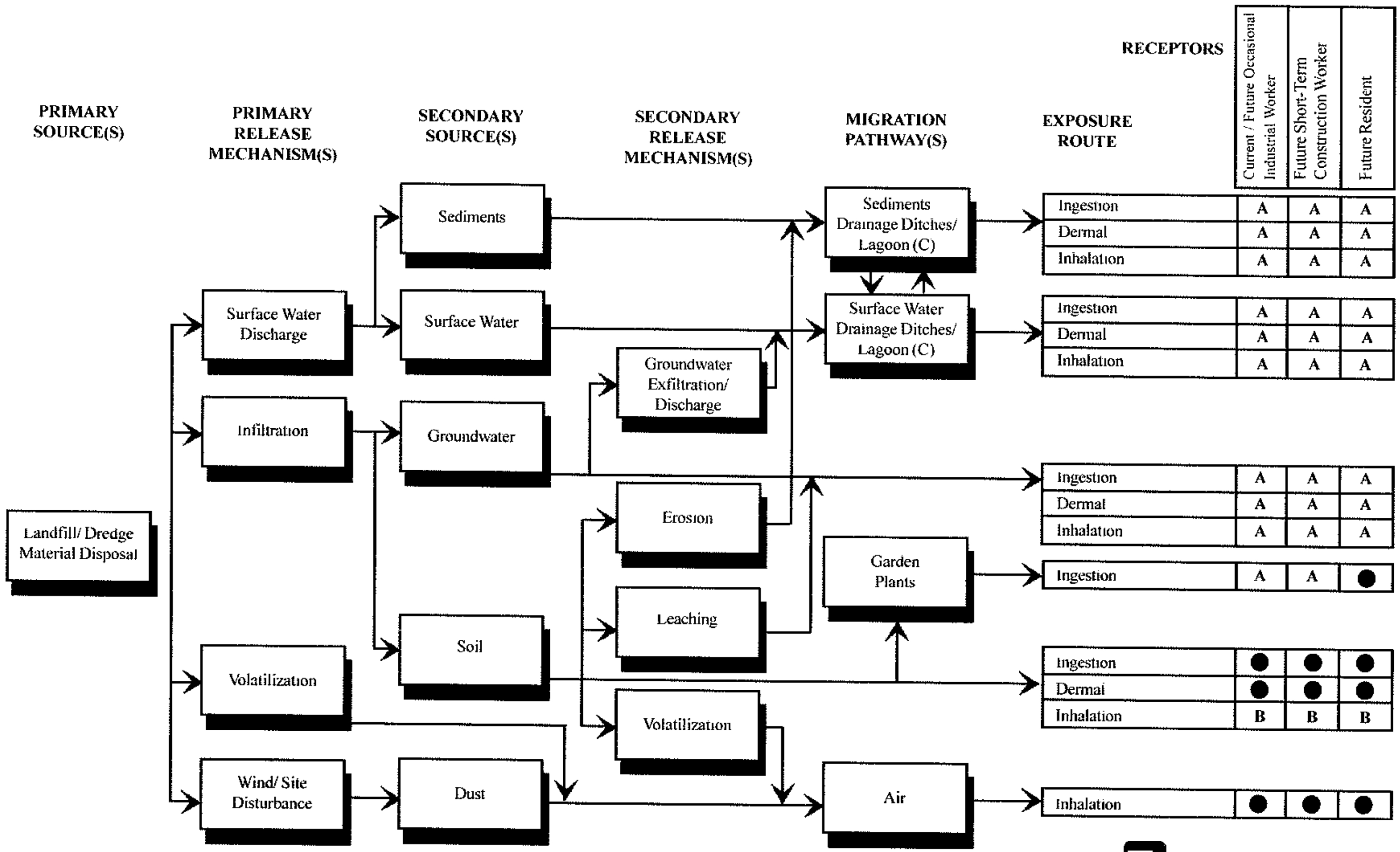
FIGURE 3-3
IRP SITE 4 CONCEPTUAL MODEL FOR HUMAN HEALTH EXPOSURE PATHWAYS

Final FS IRP Sites 2, 4, 8, & 9



A Not a complete pathway.
B Inhalation of soil is evaluated under the air pathway.
C Potential site impacts to surface water, sediment, and biota pathways assessed under Site 11, Mugu Lagoon.
● Pathways to be evaluated.

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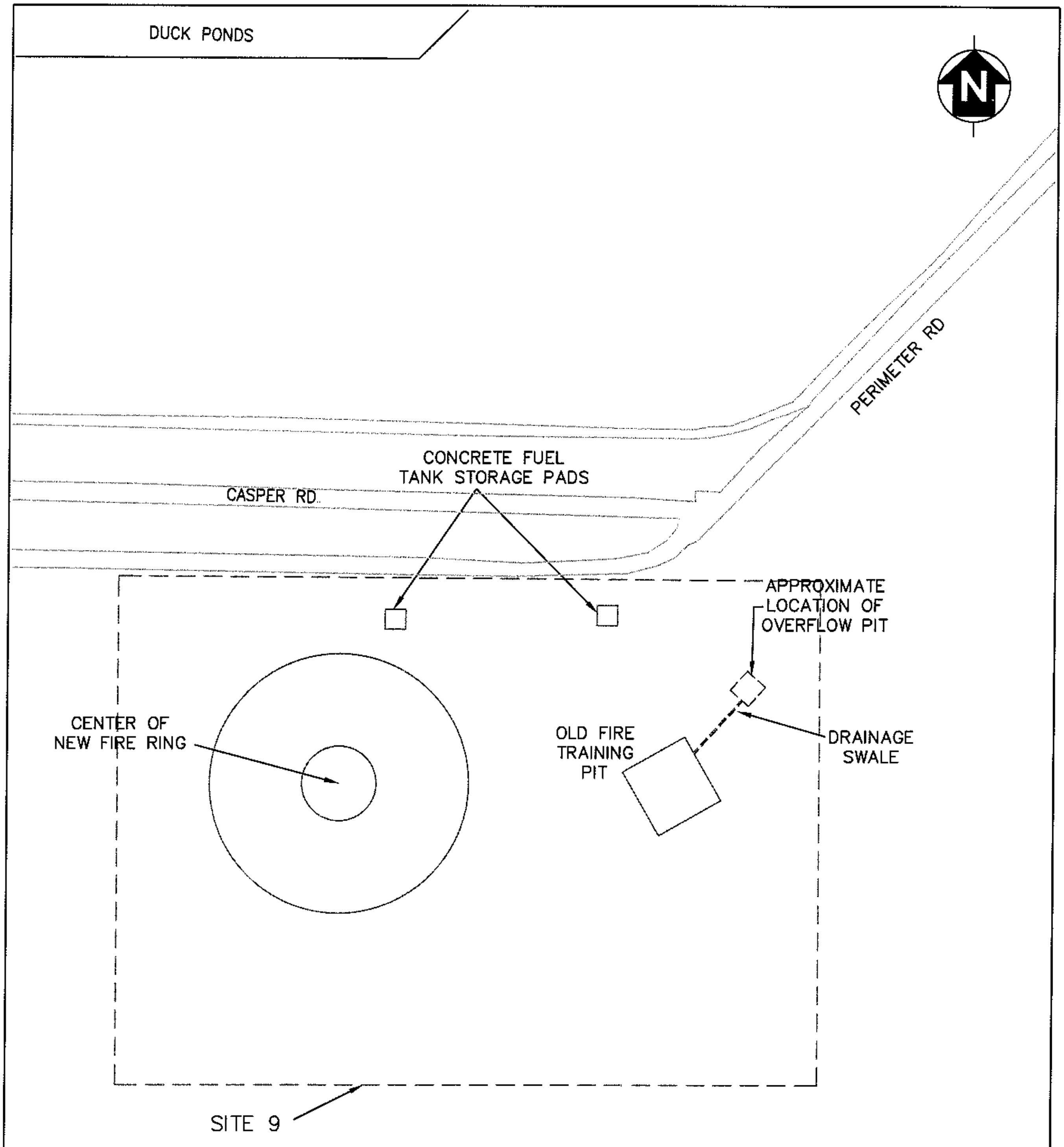
FIGURE 3-4
IRP SITE 8 CONCEPTUAL MODEL FOR HUMAN HEALTH EXPOSURE PATHWAYS

Final FS IRP Sites 2, 4, 8, & 9



75' 0 75' 150'

SCALE: 1" = 150'

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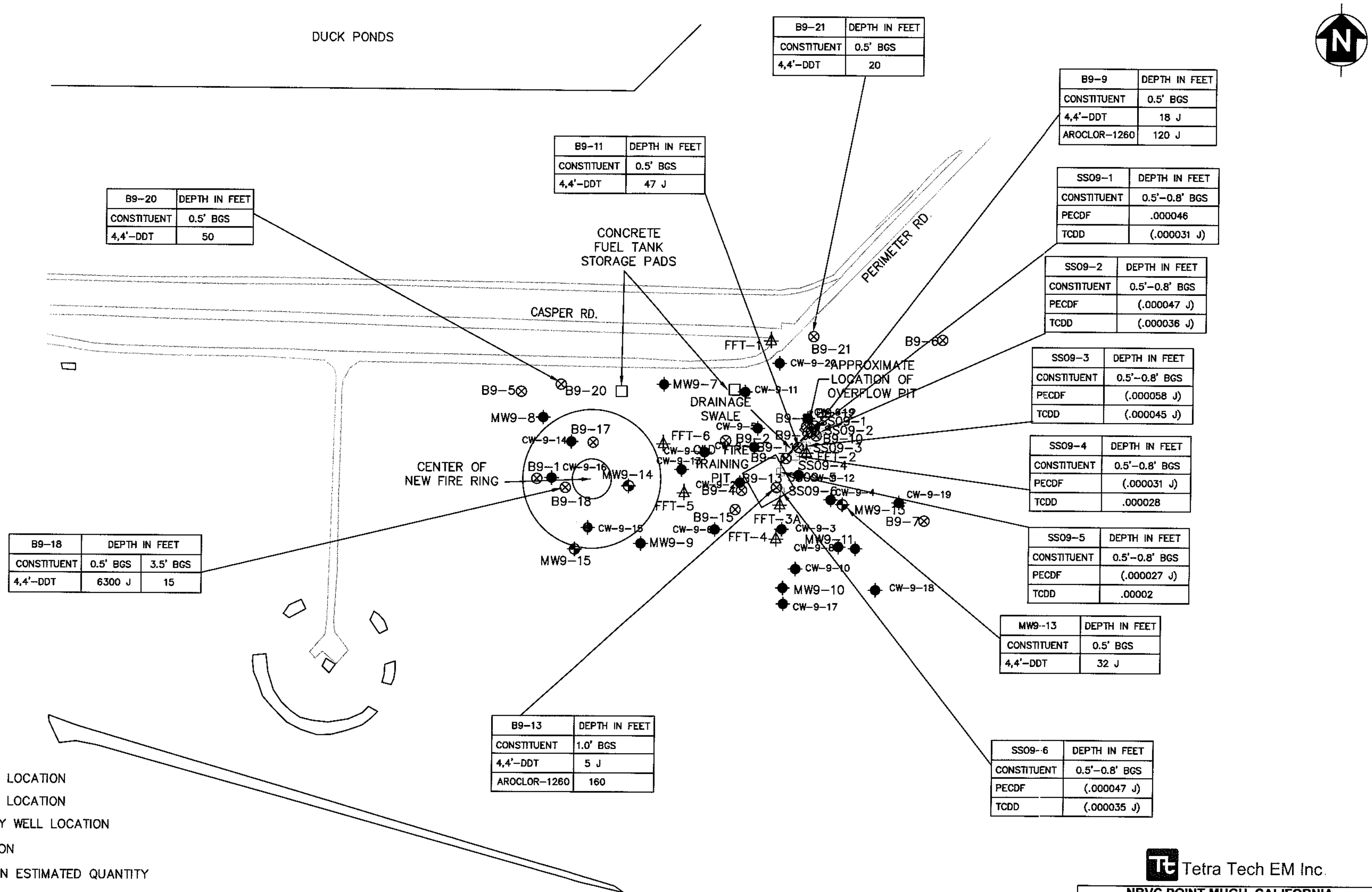
FIGURE 3-5
IRP SITE 9 MAIN BASE FIRE TRAINING AREA SOURCE AREAS

Final FS IRP Sites 2, 4, 8, & 9

Fig 3-5_fire train source.dwg - DWH - 03/31/2004 - G9016 007 04 12.02.04 18



B9-21	DEPTH IN FEET
CONSTITUENT	0.5' BGS
4,4'-DDT	20

B9-9	DEPTH IN FEET
CONSTITUENT	0.5' BGS
4,4'-DDT	18 J
AROCLOR-1260	120 J

B9-11	DEPTH IN FEET
CONSTITUENT	0.5' BGS
4,4'-DDT	47 J

B9-20	DEPTH IN FEET
CONSTITUENT	0.5' BGS
4,4'-DDT	50

SS09-1	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	.000046
TCDD	(.000031 J)

SS09-2	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	(.000047 J)
TCDD	(.000036 J)

SS09-3	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	(.000058 J)
TCDD	(.000045 J)

SS09-4	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	(.000031 J)
TCDD	.000028

SS09-5	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	(.000027 J)
TCDD	.00002

B9-18	DEPTH IN FEET	
CONSTITUENT	0.5' BGS	3.5' BGS
4,4'-DDT	6300 J	15

MW9-13	DEPTH IN FEET
CONSTITUENT	0.5' BGS
4,4'-DDT	32 J

B9-13	DEPTH IN FEET
CONSTITUENT	1.0' BGS
4,4'-DDT	5 J
AROCLOR-1260	160

SS09-6	DEPTH IN FEET
CONSTITUENT	0.5'-0.8' BGS
PECDF	(.000047 J)
TCDD	(.000035 J)

LEGEND

- RI MONITORING WELL LOCATION
- SI MONITORING WELL LOCATION
- CONFIRMATION STUDY WELL LOCATION
- ⊗ SOIL BORING LOCATION
- J DETECTED, BUT IS AN ESTIMATED QUANTITY
- UJ UNDETECTED, BUT IS AN ESTIMATED QUANTITY
- R REJECTED
- () CONCENTRATION IS BELOW THE 80% LTL/95 PERCENTILE BACKGROUND PRELIMINARY SCREEN

UNITS = μg/l (micrograms per litre)

100' 0 100' 200'
SCALE: 1" = 200'

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FIGURE 3-6
DISTRIBUTION OF SOIL CONTAMINANTS AT IRP SITE 9

Final FS IRP Sites 2, 4, 8, & 9

Fig 3-6_soil contam dwg - DWH - 03/31/2004 - G9016.007.04 12 02 04 18

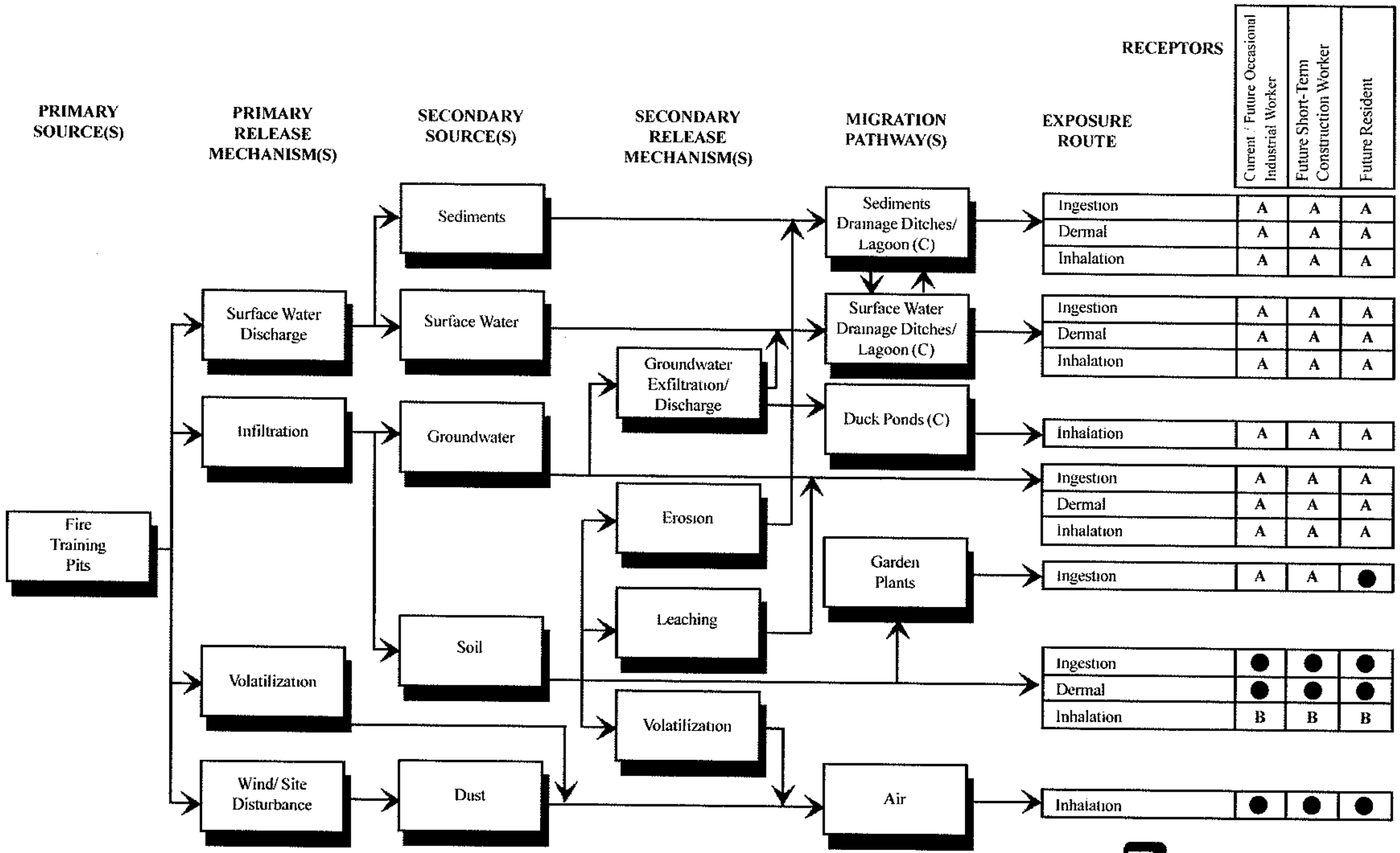

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FIGURE 3-7
IRP SITE 9 CONCEPTUAL MODEL FOR HUMAN HEALTH EXPOSURE PATHWAYS

Final FS IRP Sites 2, 4, 8, & 9

A Not a complete pathway.
B Inhalation of soil is evaluated under the air pathway.
C Potential site impacts to surface water, sediment, and biota pathways assessed under Site 11, Mugu Lagoon.
● Pathways to be evaluated.

Fig 3-7_site9 conc model.pmd - 03/31/2004 - G9016.007.04.12.02.04.18

4.0 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND REMEDIAL ACTION OBJECTIVES

This section discusses the RAO and ARARs for IRP Site 9. Risk characterization results for IRP Sites 4 and 8 showed that remedial action is not needed, so no ARAR analysis was completed for these sites. Risk results for Site 2 fell within EPA's risk management range of 1×10^{-6} to 1×10^{-4} and have resulted in the Navy making a risk management decision that remedial action is not needed. Although none of the COCs identified at Site 9 exceeded EPA's risk management range, several COCs in soil were determined to be individually contributing to a cancer risk of slightly greater than 1×10^{-6} under the future adult and child resident scenario for IRP Site 9. Although these risks would not normally warrant remedial action, the Navy has agreed with the regulatory support agencies to evaluate institutional controls as a remedial alternative for Sites 9. This agreement is documented in the meeting minutes included as Appendix B. Therefore, the ARARs and RAO presented below address only the soil pathway for Site 9. The RAO for IRP Site 9 is discussed in Section 4.4.

4.1 ARARs Overview

Identification of ARARs is a site-specific determination and involves a two-part analysis. First, a determination is made of whether a given requirement is applicable. If it is not applicable, then another determination is made of whether it is relevant and appropriate. A requirement is deemed applicable if the specific terms of a law or regulation directly address the COCs, their location, or the remedial action involved. If the jurisdictional prerequisites of the law or regulation are not met, a legal requirement may nonetheless be relevant and appropriate if site conditions are similar to conditions under which the law would apply and if the requirement is well-suited to the conditions of the site.

A requirement must be substantive in order to constitute an ARAR for activities conducted on site. Procedural or administrative requirements, such as permits and reporting requirements are not ARARs.

In addition to ARARs, the NCP provides that, where ARARs do not exist, agency advisories, criteria, or guidance are "to be considered" (TBC) useful in "helping to determine what is protective at a site or how to carry out certain actions or requirements" (55 Federal Register 8745). The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable, so they do not have the same status under CERCLA as do ARARs."

As the lead federal agency, the Navy has the primary responsibility for the identification of federal ARARs at IRP Site 9. As the lead state agency, the California DTSC has the responsibility for identifying state ARARs.

ARARs and TBCs are generally divided into three categories: chemical-specific; location-specific; and action-specific. Chemical-specific ARARs are numeric values representing health-based or risk-based standards that are modified to consider the economic and technical feasibility of implementation. Maximum contaminant levels (MCL) are examples of chemical-specific ARARs.

Location-specific ARARs govern activities to protect resources at the location of the site. Examples of location-specific ARARs include regulations that protect floodplains, wetlands, endangered species habitat, and archaeologically or historically significant resources.

Action-specific ARARs are technology- or activity-based requirements or restrictions. Examples of action-specific ARARs include monitoring requirements, effluent discharge limits, hazardous waste manifesting requirements, and occupational safety and health standards.

4.2 FEDERAL ARARs

This section summarizes the federal chemical-, location-, and action-specific ARARs for IRP Site 9.

4.2.1 Federal Chemical-Specific ARARs

There are no federal chemical-specific ARARs for soil contaminated with the COCs identified at Site 9.

4.2.2 Federal Location-Specific ARARs

Most of the federal location-specific ARARs associated with remediation of soils at IRP Site 9 are related to the coastal location of the site.

Executive Order 11988, Protection of Floodplains, requires that actions taken by the federal government avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of floodplains. NBVC Point Mugu is located within a 100-year flood plain. Although flooding is not a major threat to IRP Site 9, because of their proximity to the ocean, the sites may be subject to storm surge. Thus, Executive Order 11988 may be relevant and appropriate. Also, because wetlands are present at NBVC Point Mugu, Executive Order 11990, Protection of Wetlands, is potentially applicable.

Federal property is excluded from the Coastal Zone Management Act making the act not applicable. However, because IRP Site 9 are located along the coast, the Coastal Zone Management Act is relevant and appropriate. This act requires that activities be conducted in a manner consistent with approved state management programs.

Although no discharge of dredge or fill material is planned as part of any remedial activity at IRP Site 9, the Clean Water Act (CWA), Section 404, which prohibits such activity, is applicable.

The Migratory Bird Treaty Act of 1972 protects almost all species of native birds in the United States from an unregulated "take" (such as, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting). Because migratory birds could be present at Site 9, this regulation may be applicable.

The Endangered Species Act of 1973 protects critical habitat upon which endangered or threatened species depend. Because threatened and endangered species and critical habitats occur in the area of IRP Site 9, this act may be applicable.

4.2.3 Federal Action-Specific ARARs

Most federal action-specific ARARs are related to handling RCRA hazardous waste. RCRA waste will not be generated as part of the remedial actions for IRP Site 9. Thus, the regulations applicable to generating and handling hazardous waste do not pertain.

One requirement that is neither applicable nor relevant and appropriate, but rather TBC, is the RCRA requirement for Closure of Land Treatment Units. This requirement specifies closure and post-closure care requirements for hazardous waste land treatment units. This regulation is not applicable because there are no land treatment units at the sites. However, the requirements may be considered in determining the controls at the closure of the sites.

4.3 STATE ARARs

This section summarizes the state chemical-, location-, and action-specific ARARs for IRP Site 9

4.3.1 State Chemical-Specific ARARs

There are no state chemical-specific ARARs for soil contaminated with the COCs identified at IRP Site 9.

4.3.2 State Location-Specific ARARs

There are two potential state location-specific ARARs. The California Coastal Act of 1976 regulates activities associated with development to control direct, significant impacts on coastal waters and to protect state and national interests in California coastal resources. This regulation is applicable because Site 9 are within the coastal zone.

The "endangered species habitat" section of the Fish and Game Code prohibits the import, export, taking, possession, and selling of any endangered or threatened species. This code may be applicable because threatened and endangered species may occur at IRP Site 9.

4.3.3 State Action-Specific ARARs

The Navy has determined that 22 California Code of Regulations (CCR) 67391.1 "Requirements for Land Use Covenants" is the only state action-specific ARAR that is pertinent to the institutional control alternative for IRP Site 9. Specifically, 67391.1(e)(2) states:

> *"Whenever the Department determines that it is not feasible to record a land use covenant for property owned by the federal government, such as transfers from one federal agency to another, the Department and federal government may use other mechanisms to ensure that future land use will be compatible with the levels of hazardous materials, hazardous wastes or constituents, or hazardous substances which remain on the property. Examples include: Amendments to the federal government facility master plan, physical monuments, or agreements between the federal government facility and the Department."*

The Navy has determined that a land use covenant is not feasible for NBVC Point Mugu since there are no plans to transfer the property. Therefore, revisions to the NBVC Point Mugu regional shore infrastructure plan (RSIP) will be the "other mechanism" that will be used to comply with this ARAR. The RSIP will be revised to include procedures that will ensure the long-term effectiveness and protectiveness of the institutional controls at IRP Site 9. These revisions will be described in detail in the remedial action plan (RAP) that will be prepared in conjunction with the record of decision (ROD) for IRP Sites 2,4, 8 and 9. The descriptions of the institutional controls included in the RAP and ROD will follow the two national agreements described in Section 5.3.

4.4 REMEDIAL ACTION OBJECTIVES

RAOs are established to allow identification and screening of remedial alternatives that achieve protection of human health and the environment consistent with reasonably anticipated land use. The determination of RAOs includes consideration of site-specific risks and ARARs in accordance with CERCLA as amended by the NCP and the Superfund Amendments and Reauthorization Act (SARA). As described in Section 2.0, industrial land use is the anticipated land use scenario for IRP Site 9. However, the RAO presented below addresses the risk from exposure of future residents to contaminated soil at IRP Site 9.

Based on CERCLA, the ARARs, and the Phase I RI HHRA (TtEMI 2000), the following RAO is proposed for soils at IRP Site 9:

- Prevent exposure of future residents to soil contaminated with carcinogens that result in an ELCR greater than 1×10^{-6}.

5.0 SCREENING OF REMEDIAL ACTION ALTERNATIVES

Screening of potential remedial measures is used as a tool to focus detailed consideration of remedial action alternatives. The screening evaluation typically reduces the number of potential remedial measures that undergo more detailed and extensive analysis. Thus, in this section, remedial measures are evaluated using more general criteria than in the detailed evaluation of alternatives in Section 6.0.

The Phase I RI (TtEMI 2000) determined that there are no COCs at IRP Sites 4 and 8. As NFA sites, remedial action alternatives are not necessary. HHRA risks calculated for soils at Sites 2 and 9 in the Phase I RI fall within the EPA risk management range. The Phase I RI (TtEMI 2000) and RI for Groundwater (TtEMI 2004) determined that there are no COPCs or COPECs for groundwater at IRP Sites 2, 4, 8, and 9. Thus, the use of active remediation technologies at these sites is not warranted, and active remediation technologies are not screened as remedial action alternatives.

Table 5-1 summarizes the screening of remedial measures for IRP Site 9. The remedial measures are screened for effectiveness, implementability, and cost. Descriptions of the three evaluation criteria are provided below.

Effectiveness

Effectiveness is a measure of the extent to which a given remedial measure can eliminate significant threats to public health and the environment through reduction of the toxicity, mobility, or volume of contaminants at a site. Effectiveness includes both short-term and long-term effectiveness and permanence. Short-term effectiveness evaluates effectiveness for the time period of implementation of a response action. Long-term effectiveness evaluates effectiveness for the time period after the response action is in place.

Implementability

Implementability is a measure of the technical and administrative feasibility of implementing, operating, monitoring, and maintaining a remedial measure. If a remedial measure includes a technology, implementability also evaluates operation, monitoring, and maintenance of the technical components of the remedial measure.

Cost

For screening purposes, cost provides a reference for comparing potential remedial measures. During screening, cost does not guide the development or exclusion of particular remedial measures for detailed evaluation. Rather, costs are developed on an approximate order-of-magnitude basis, such as, within 50 percent accuracy.

5.1 GENERAL RESPONSE ACTIONS

This section describes broad categories of remedial measures, called general response actions, that could be used to achieve the RAOs discussed in Section 4.4 of this FS. A particular general response action might be accomplished by any of several specific response actions. In turn, a single response action might encompass several specific methods or process options. For example, "institutional control" is a general response action; "administrative control for access restriction" is a specific response action; and "posting" is a process option.

The general response actions presented for evaluation in this section are medium-specific for soil contaminants.

Appropriately implemented, the following general response actions, alone or in combination, can achieve the RAO for IRP Site 9:

- NFA
- Institutional controls (IC), including access controls such as signage and postings and legal controls such as land use restrictions.

CERCLA requires that the NFA alternative be included among the general response actions evaluated in all FSs. The NFA alternative serves as a baseline for comparison for other alternatives

ICs are nonengineering measures, usually legal or physical means, of limiting potential exposures to a site or medium of concern usually through legal administrative restrictions. Examples of ICs cited in the NCP include land and resource use (for example, water) deed restrictions, well-drilling prohibitions, building permits, well use advisories, and deed notices. ICs can also include access restrictions, such as fencing and site monitoring. Although potential exposure to contaminants can be reduced by ICs, the contaminated media are not directly remediated.

5.2 NO FURTHER ACTION

The NFA alternative, required under CERCLA, provides a baseline for comparing other alternatives. This alternative entails no activities to contain or remediate contaminants at a site, provides no treatment for contaminants, and provides no legal or administrative protection of human health or the environment beyond cleanup criteria under industrial use scenarios. It also does not ensure continued industrial land use.

Under the NFA alternative, existing actions, such as groundwater monitoring, may continue as part of other ongoing site activities.

Effectiveness

The NFA alternative provides no additional control of exposure to contaminated soils.

Implementability

The NFA alternative is easy to implement, because it does not require any additional actions to be taken.

Cost

There are no costs associated with the NFA alternative because no additional actions are taken.

The NFA alternative does not meet the RAO for IRP Site 9, because it does not fully protect future residents at Site 9.

5.3 INSTITUTIONAL CONTROLS

ICs are nonengineering measures used to manage site risks, usually legal or administrative controls that limit potential exposure to contamination and/or protect and ensure the integrity of the remedy. Examples of ICs cited in the NCP include land and resource use (for example water) restrictions, well-drilling prohibitions, building permit requirements, and well use advisories. Because the HHRA and this FS are based on the present and likely future industrial land use scenario, land use restrictions are the only form of IC needed in the ROD to limit potential exposure to any residual contamination. If it is later determined that any residual contamination at IRP Site 9 is compatible with unlimited land use, any land use restrictions put into place would no longer be needed.

The Navy and the EPA recently finalized a negotiated agreement on implementation of LUCs entitled "Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and other Post-ROD Actions." (DOD 2003) A similar agreement was also recently implemented among the Environmental Council of States (ECOS), DOD, U.S. Department of the Interior (DOI), U.S. Department of Energy (DOE), and EPA. The Navy will implement ICs according to these agreements and administratively implement through the RSIP.

The evaluation criteria used in the HHRA performed during the Phase I RI (TtEMI 2000) were predicated on IRP Site 9 remaining as an industrial site. That is, exposure scenarios used in the HHRA for IRP Site 9 were based on industrial and residential exposures. The intended future use of IRP Site 9, which will remain under the control of NBVC Point Mugu, is industrial in nature, however, it is the policy of the DTSC to evaluate a residential scenario as well.

5.3.1 Land Use Restrictions

The LUC action entails no activities to contain or remediate contaminants at a site, and it provides no treatment for contaminants. However, it can ensure continued industrial use, and thus provide protection of human health and the environment at the level of cleanup criteria under industrial use scenarios.

The LUC action has two options for implementation. According to the "Institutional Control Protocol at Open Bases" (California Military Environmental Coordination Committee [CMECC] Site Cleanup Performance Action Team 1999), the preferred method for implementing LUCs is to record these controls in the Regional Shore Infrastructure Plan for NBVC Point Mugu. A RSIP establishes land uses and similar "zoning-like" requirements. It is used in project planning and in making land use decisions. According to the CMECC document, eight action items must be evaluated and/or completed and are summarized as follows:

1. Whenever ICs are necessary to protect human health or the environment, the ICs should be included as a response action or part of a response action in a ROD.

2. The ROD should contain a description of the IC required, the reason for the requirement, and any specific conduct that is prohibited.

3. The Navy and the regulatory agencies should evaluate the use of permanent markers for ensuring adherence to the ICs.

4. The Navy and the regulatory agencies need to verify the effectiveness of the RSIP for implementing the ICs.

5. The specific IC language added to the RSIP should include a description of the IC that clearly identifies the specific conduct that is prohibited by the IC, and it should include all of the requirements specified in the ROD for implementing the IC.

6. The ROD should include provisions regarding land use changes that occur post-ROD.

7. The ROD should provide that the Navy will verify maintenance of the ICs through the CERCLA 5-year review process.

8. The ROD should provide that the Navy will notify regulatory agencies when any installation property subject to ICs is expected to be transferred. Another option for implementing LUCs is through the establishment of an memorandum of agreement (MOA) between NBVC Point Mugu and the appropriate regulatory agencies, the California DTSC and the RWQCB, Los Angeles Region. Generally, a MOA is used if it is determined that a RSIP is not the most appropriate vehicle for implementing LUCs. However, a MOA can also be used as a supplement to a RSIP or other land use planning document.

Under this action, existing programs, such as groundwater monitoring, may continue as part of ongoing site activities.

Effectiveness

The HHRA in the Phase I RI (TtEMI 2000) depends on IRP Site 9 remaining as an industrial site. ICs that restrict land use at this site to industrial uses would effectively prevent future land use changes. They are necessary to ensure that human health and the environment are protected at the level of cleanup criteria under industrial use scenarios.

Implementability

Implementation of ICs that restrict land use requires low to moderate legal and administrative effort, depending upon which implementation option is used.

Cost

Costs to implement ICs to restrict future land use at IRP Site 9 are expected to be low to moderate, depending upon which implementation option is used.

5.3.2 Administrative Control for Site Access – Signs and Postings

The "signs and postings" action entails no activities to contain or remediate contaminants at a site, and it provides no treatment for contaminants. It also does not ensure continued industrial or wildlife management land use. However, it does provide protection of human health and the environment by controlling site access.

Under this action, existing programs, such as groundwater monitoring, may continue as part of ongoing site activities.

Effectiveness

Signs and postings are administrative controls that effectively restrict site access and thus prevent exposure to residual contaminants at the sites. However, they do not ensure continued industrial or wildlife management land use.

Implementability

The posting of warning and entry restrictions signs to restrict site access requires only minimal effort and equipment.

Cost

Costs to post warning and entry restrictions signs to restrict site access are expected to be low.

5.4 SELECTION OF SPECIFIC ALTERNATIVES

Several response actions and method options were screened for implementation at IRP Sites 2, 4, 8 and 9 to meet the RAO. Table 5-1 summarizes the general response actions, technologies and process options identified for IRP Site 9. The previous sections used the general criteria of effectiveness, implementability, and cost to select options for further detailed evaluation in Section 6.0.

The following are options selected for further evaluation for these sites.

Alternative 1 – No further action

Under this alternative, no action would be taken to alter the conditions at Site 2, 4, 8, and 9.

Alternative 2 – Institutional Land Use Controls

ICs to restrict land use is retained for detailed evaluation as a method to maintain site conditions and uses consistent with the risk scenarios on which the HHRA are based.

As a component of implementing ICs to restrict land controls, the CMECC Site Cleanup Performance Action Team (1999) recommends evaluating the use of permanent markers at affected sites as another mechanism for ensuring adherence to the controls. They suggest "concrete landmarks containing a plaque describing the conduct prohibited." Permanent markers will be considered as an option in the detailed evaluation of alternatives.

Alternative 3 – Institutional Administrative Control for Site Access

Because signs and postings do not contribute to maintaining industrial or wildlife management use scenarios, this action is not retained for further consideration.

TABLES

TABLE 5-1: SUMMARY OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS SCREENING AT IRP SITE 9

General Response Action	Technology Type	Process Option(s)	Effectiveness	Implementability	Cost Capital	Cost O&M	Screening Comments
Institutional Controls	Site Controls	Land Use Controls	Procedural administrative control effective to restrict site access. Effectively protects human health under the industrial land use scenario, as designated by NBVC. Minimizes potential for unauthorized activities. Does not ensure continued industrial land use.	Easy to implement. Legal requirements and authority necessary.	Low	Low	Retained in conjunction with administrative procedures.
		Administrative Procedures	Legal administrative control effective to restrict site development and land use consistent with industrial risk scenario, as designated by NBVC.	If incorporated in the NBVC RSIP, then easy to implement. If negotiated as an MOA with regulators, may require more time and effort.	Low	Low	Retained in conjunction with administrative procedures.

Notes:

IRP Installation Restoration Program
LUC Land use control
MOA Memorandum of agreement
NBVC Naval Base Ventura County
O&M Operation and maintenance
RSIP Regional Shore Plan

6.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section evaluates the remedial alternatives based on nine criteria as required by the NCP in 40 CFR 300.430(e) (EPA 1990). These nine criteria are listed and discussed below.

- **Overall Protection of Human Health and the Environment.** This criterion assesses whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the evaluations of long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Protectiveness focuses on how site risks are reduced or eliminated by each alternative. Risk reductions are associated with how effectively an alternative meets the RAOs. This criterion is considered a threshold and must be met by the selected alternative.

- **Compliance with ARARs.** This criterion is used to evaluate whether each alternative will meet all identified federal and state ARARs, or whether justification exists for waiving one or more ARARs. The detailed analysis will describe how each alternative will meet these requirements. This criterion is also a threshold that must be met by the selected alternative unless an ARAR is waived. Section 4.0 provides a summary of the ARARs evaluation.

- **Long-Term Effectiveness and Permanence** Each alternative is evaluated in terms of risk remaining at the site after RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of controls used to manage the risk posed by treatment of residuals or untreated wastes. The following criteria are considered:

  - Adequacy of mitigative controls

  - Reliability of mitigative controls

  - Magnitude of residual risk

- **Reduction of Toxicity, Mobility, or Volume through Treatment.** This evaluation criterion addresses the statutory preference for treatment options that permanently and significantly reduce toxicity, mobility, or volume of the chemicals. This preference is satisfied when treatment reduces the principal threats through the following:

  - Destruction of toxic chemicals

  - Reduction in chemical mobility

  - Reduction of the total mass of toxic chemicals

  - Reduction of total volumes of contaminated media

- **Short-Term Effectiveness**. This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until RAOs are met. Under this criterion, alternatives are evaluated with respect to their effects on human health and the environment during remedial action implementation. The following factors are considered:

    - Exposure of the community during implementation
    - Exposure of the workers during construction
    - Environmental impacts
    - Time required to achieve RAOs

- **Implementability**. This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The following factors are considered:

    - Ability to construct the technology
    - Reliability of the technology
    - Monitoring considerations
    - Availability of equipment and specialists
    - Ability to obtain approvals from regulatory agencies

- **Cost**. The cost estimate for each alternative is based on estimates of capital and operation and maintenance (O&M) costs. Costs are developed following EPA guidelines for cost estimates during the FS (EPA 2000). The types of costs that are assessed include the following:

    - Capital costs, including both direct and indirect costs
    - Annual O&M costs, including long-term effectiveness monitoring cost
    - Periodic cost, including preparation of the 5-year review
    - Net present worth of capital, O&M costs, and periodic costs

  Direct costs include the purchase of equipment, labor, and materials necessary to install the alternative. Indirect costs include those for engineering, financial, and other services, such as testing and monitoring. Annual O&M costs for each alternative include maintenance materials, labor, and auxiliary materials, as well as operating costs.

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. The cost estimates of the remedial alternatives are based on estimates provided through Remedial Action Cost Engineering and Requirements (RACER) (RACER 2003).

The present worth analysis is performed on all remedial alternatives using a 3.2 percent discount (interest) rate over a period of 30 years. Inflation and depreciation are not considered in preparing the present worth costs. Appendix D contains spreadsheets showing each component of the present worth costs.

- **State Acceptance.** The assessment of the state's concerns regarding the proposed remedial alternative may not be completed until comments of the remedial investigation/feasibility study (RI/FS) are received. However, they may be discussed to the extent possible in the proposed plan issued for public comment, as detailed in 40 CFR 300.43(e)(iii)(H) The state's concerns that will be assessed include the following:
    - The state's position and key concerns related to the preferred alternative and other proposed alternatives
    - State comments on ARARs
- **Community Acceptance.** This assessment involves identifying community support for, reservations about, or opposition to various components of the alternatives. This assessment may not be completed until comments on the proposed plan are received, as detailed in 40 CFR 300.43(e)(iii)(I).

The following text provides a detailed analysis of the remedial alternatives selected for detailed analysis in Section 5.4 with respect to the nine criteria.

6.1 ALTERNATIVE 1: NO FURTHER ACTION

The evaluation of the NFA alternative, as required by CERCLA, serves as a baseline for comparison to other remedial alternatives.

6.1.1 Overall Protection of Human Health and the Environment

The HHRA in the Phase I RI (TtEMI, 2000) for IRP Sites 2, 4, 8, and 9 determined that the industrial scenario cancer risks associated with IRP Sites 2 and 9 are within the EPA's risk management range of 1×10^{-4} to 1×10^{-6} that EPA considers acceptable for industrial use land. Only one COC was identified at IRP Site 2 and the associated risk to the current industrial worker was very close to the low end of the risk range. Therefore, the Navy has made a risk management decision that no further action is appropriate for Site 2. Several COCs were identified at IRP Site 9 and the associated total cancer risk, although within the risk range, was such that NFA may not be fully protective of human health and the environment. The HHRA also determined that the wildlife management scenario cancer risks associated with IRP Site 4 are below the EPA's acceptable level of 1×10^{-6}, as long as the site is maintained for wildlife management. According to the HHRA, IRP Site 8 is EPA's acceptable level for cancer risks under all scenarios. In addition, no chronic toxicity or ecological risks were identified for any of the sites. Thus, the NFA alternative is expected to provide protection of human health and the environment at the level of cleanup criteria under a wildlife management scenario for IRP Site 4. The NFA alternative is protective of human health and the environment for all scenarios for IRP Site 8.

6.1.2 Compliance with ARARs

The NFA alternative does not meet federal, state, and local ARARs.

6.1.3 Long-Term Effectiveness and Permanence

The NFA alternative leaves the fate of contaminants uncertain because there are no administratively recorded institutional controls to prevent nonindustrial use of IRP Site 9. Therefore, residual contaminants would remain at this site at concentrations protective for industrial exposures, but potentially not protective for other exposure scenarios, such as residential. The NFA alternative is effective in the long-term for IRP Sites 4 and 8, because according to the HHRA, IRP Site 8 is "unconditionally acceptable" under all scenarios and IRP Site 4 is protected in perpetuity as a wetland. No further action is effective for Site 2 because the risk to industrial workers falls within the acceptable risk range.

6.1.4 Reduction of Toxicity, Mobility, or Volume of Contaminants

The NFA alternative does not reduce the toxicity, mobility, or volume of contaminants through treatment at IRP Site 9. However, because the cancer risks for IRP Sites 2, 4 and 8 are within or below the HHRA acceptable levels for the associated exposure scenarios, no further action is necessary and reduction of toxicity, mobility or volume is not warranted.

6.1.5 Short-Term Effectiveness

The NFA alternative is expected to achieve short-term effectiveness at Sites 2, 4, 8 and 9 because existing risks to the surrounding population are minimal, and no remedial work is done under the NFA alternative.

6.1.6 Implementability

The NFA alternative can be implemented easily, because it does not require any further remedial activities.

6.1.7 Cost

The NFA alternative would incur no additional costs.

6.1.8 State Acceptance

The state acceptance criterion requires the responsible party, the Navy, to address the state's comments and concerns for each potential remedy. The state's acceptance may not be completed until public comments from the RI/FS are received, but it may be discussed in the Proposed Plan (PP)/draft RAP. Further, the state, as the lead regulatory agency must concur with the preferred remedy presented in the FS. The acceptance of remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

6.1.9 Community Acceptance

The community acceptance criterion requires the responsible party, the Navy, to address the public's comments and concerns for each potential remedy. This criterion will be completed after public comments are received. The acceptance of the remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

6.2 ALTERNATIVE 2: LUCs

Alternative 2, LUCs, would consist of ICs, yearly SIs and maintenance, and five-year reviews. ICs would include implementing LUCs (CMECC Site Cleanup Performance Action Team 1999) to record them in the RSIP for NBVC Point Mugu. In addition, Alternative 2 would include the establishment of an MOA between NBVC Point Mugu and the appropriate regulatory agencies, DTSC and the RWQCB. As a component of implementing Alternative 2, the use of permanent site markers is considered as an additional mechanism for ensuring adherence to LUCs.

Yearly operations and maintenance would include SIs to evaluate if site conditions have changed and maintenance of any physical features (such as signage) that may be established by the RSIP and MOA. Due to the minimal risks proposed by site COCs, no soil or groundwater monitoring is considered necessary. However, five-year reviews would be conducted to, in part, determine if additional monitoring is necessary.

6.2.1 Overall Protection of Human Health and the Environment

In the Phase I RI (TtEMI 2000) and this FS, the HHRA for IRP Site 9 is based on an industrial and residential exposure scenario. Alternative 2 would ensure continued industrial land use, and thus would provide overall protection of human health and the environment by restricting future land use at these sites to industrial purposes.

6.2.2 Compliance with ARARs

Alternative 2, LUCs, is expected to meet all federal, state, and local ARARs.

6.2.3 Long-Term Effectiveness and Permanence

Alternative 2 is expected to meet long-term effectiveness and permanence goals and RAOs for IRP Site 9 by restricting future land use at this site to industrial purposes. The HHRA results for IRP Site 9 are within the acceptable risk management range, however, LUCs will ensure long-term effectiveness and permanence by becoming administratively recorded in the RSIP

6.2.4 Reduction of Toxicity, Mobility, or Volume of Contaminants

Alternative 2 is not expected to reduce the toxicity, mobility, or volume of contaminants at IRP Site 9 through treatment because no treatment is used

6.2.5 Short-Term Effectiveness

Alternative 2 is expected to meet short-term effectiveness goals for IRP Site 9 because industrial risks for these sites currently fall within EPA's risk management range. In addition, no chronic toxicity or ecological risks were identified for any of the sites.

6.2.6 Implementability

Alternative 2 is implemented through legal and administrative means and is considered moderately easy to implement. It is expected to be easy to incorporate LUCs into the NBVC Point Mugu RSIP. Implementing LUCs as an MOA with regulators may require more time and effort. However, neither method of implementation is expected to be difficult.

The implementation time for Alternative 2 is expected to be 3 to 6 months, depending upon the method of implementation and the decision to install permanent site markers.

6.2.7 Cost

The total present worth cost for implementing Alternative 2 at IRP Site 9 is $192,300. Cost details are provided in Appendix D.

6.2.8 State Acceptance

The state acceptance criterion requires the responsible party, the Navy, to address the state's comments and concerns for each potential remedy. The state's acceptance may not be completed until public comments from the RI/FS are received, but it may be discussed in the PP/draft RAP. Further, the state, as the lead regulatory agency must concur with the preferred remedy presented in the FS. The acceptance of remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

6.2.9 Community Acceptance

The community acceptance criterion requires the responsible party, the Navy, to address the public's comments and concerns for each potential remedy. This criterion will be completed after public comments are received. The acceptance of the remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

6.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The following analysis compares the two alternatives for each of the nine evaluation criteria.

6.3.1 Overall Protection of Human Health and the Environment

Both of the alternatives provide overall protection of human health and the environment from soil contaminants if the land use scenario used in the HHRA remains valid. Both of the alternatives meet the requirements of the RAOs, because the exposure risks calculated in the Phase I RI (TtEMI 2000) fall within EPA's risk management range or below EPA's acceptable level. Based on the exposure risks calculated in the HHRA, COCs were only identified for IRP Sites 2 and 9. In addition, no ecological risks were identified for any of the sites. Therefore, all of the evaluated alternatives are expected to provide protection of human health and the environment. The NFA alternative is protective of human health and the environment for Sites 2, 4 and 8. However, the NFA alternative does not provide any method to ensure that the land use scenarios used in the HHRA for IRP Site 9 remain valid.

LUCs provide additional protection from potential soil exposures by limiting changes to site conditions and site use. The HHRA is based on a residential exposure scenario for IRP Site 9. Thus, future land use changes might invalidate the risk scenarios for these sites. Alternative 2 can ensure that the industrial land use scenarios, respectively, remain valid.

6.3.2 Compliance with ARARs

Both of the selected remedial alternatives are expected to comply with ARARs.

6.3.3 Long-Term Effectiveness and Permanence

The NFA alternative provides limited long-term effectiveness for IRP Site 9, because there is no provision for ensuring industrial land use. Alternative 2 can effectively limit land use options by ensuring industrial land use.

6.3.4 Reduction of Toxicity, Mobility, or Volume of Contaminants

Neither of the alternatives evaluated reduces the toxicity, mobility, or volume of contaminants through treatment at IRP Site 9. However, remedial treatment technologies to reduce toxicity, mobility, or volume of contaminants are not required, because the HHRA indicates that residual risks are within the risk management range and are acceptable for the industrial use scenario at IRP Site 9 with LUCs.

6.3.5 Short-Term Effectiveness

Both of the evaluated alternatives provide good short-term effectiveness. The NFA alternative requires no on-site activities, so there is no potential for worker exposure. Alternative 2 may require minimal on-site activity in the form of placing permanent site markers delineating land use restrictions. Neither of the evaluated alternatives increases the potential risk to off-site populations during implementation.

6.3.6 Implementability

The NFA alternative is the easier alternative to implement, because it does not require any action. Alternative 2 initially imposes legal and administrative restrictions to land use, and requires minimal on-site activity. Alternative 2 is also expected to be easy to implement.

6.3.7 Cost

No additional costs are associated with the NFA alternative. The cost of implementing Alternative 2 is estimated at $192,300.

6.3.8 State Acceptance

The state acceptance criterion requires the responsible party, the Navy, to address the state's comments and concerns for each potential remedy. The state's acceptance may not be completed until public comments from the RI/FS are received, but it may be discussed in the PP/draft RAP. Further, the state, as the lead regulatory agency, must concur with the preferred remedy presented in the FS. The acceptance of remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

6.3.9 Community Acceptance

The community acceptance criterion requires the responsible party, the Navy, to address the public's comments and concerns for each potential remedy. This criterion will be completed after public comments are received. The acceptance of the remedial alternatives will be fully addressed during the public comment period and during preparation of the PP/draft RAP and the ROD/final RAP.

7.0 SUMMARY OF EVALUATION

This FS is prepared to be consistent with CERCLA requirements defined in EPA and Navy guidance documents. The purpose of the FS is to develop and evaluate alternative remedial actions to address IRP Sites 2, 4, 8, and 9. NFA and institutional land use restrictions for industrial purposes were the two alternatives identified, evaluated and ranked for the sites.

Based on the comparative analysis of the remedial action alternatives in Section 6.0 the preferred remedial action for IRP Sites 2, 4 and 8 is the NFA alternative The preferred remedial action for IRP Site 9 is Alternative 2: LUCs.

7.1 IRP SITES 2, 4, AND 8: NFA

The NFA alternative (see Section 6.1) appears to offer the best balance of performance for IRP Sites 2, 4 and 8. No remediation is warranted for Sites 4 and 8, because the Phase I RI determined that no contaminants of any significance are present at the sites in any amount hazardous to human health and the environment, and because the risks calculated in the HHRA of the Phase I RI (TtEMI 2000) fall within EPA's acceptable level for residential use. In addition, no ecological risks were identified for the sites. Risks calculated for Site 2 fall within EPA's acceptable risk range and therefore, the Navy has made a risk management decision that no further action is warranted.

7.2 IRP SITE 9: INSTITUTIONAL LAND USE RESTRICTIONS

Institutional land use restrictions (see Section 6.2) appear to offer the best balance of performance for IRP Site 9. Conventional remediation technologies are not warranted for this site because the Phase I RI (TtEMI 2000) determined that the industrial cancer risks calculated in the HHRA fall within EPA's risk management range of 1×10^{-4} to 1×10^{-6} And finally, no chronic toxicity or ecological risks were identified for IRP Sites 2 and 9.

LUCs are recommended because they are effective in defining and preventing changes in future land use that could increase exposure at IRP Site 9. LUCs also ensure overall protection of human health and the environment.

Implementation of institutional land use restrictions could include any or all of the methods and provisions discussed in Section 6.2.

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APPENDIX A
RESPONSE TO COMMENTS FROM DTSC ON DRAFT FS

AECRU Contract Number N68711-00-D-0005
Delivery Order 0007

RESPONSES TO REGULATORY AGENCY COMMENTS ON THE DRAFT FEASIBILITY STUDY FOR INSTALLATION RESTORATION PROGRAM SITES 2, 4, 8, AND 9

NAVAL BASE VENTURA COUNTY POINT MUGU, CALIFORNIA

AUGUST 26, 2003

Prepared for

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RESPONSES TO REGULATORY AGENCY COMMENTS ON THE DRAFT FEASIBILITY STUDY FOR INSTALLATION RESTORATION PROGRAM SITES 2, 4, 8, AND 9 NAVAL BASE VENTURA COUNTY, POINT MUGU SITE, CALIFORNIA

This document presents the U.S. Department of the Navy's (Navy) responses to comments from the California Environmental Protection Agency's Department of Toxic Substances Control (DTSC) on the "Draft Feasibility Study for Installation Restoration Program Sites 2, 4, 8, and 9, Naval Base Ventura County, Point Mugu, California," dated March 19, 2003.

RESPONSES TO DTSC COMMENTS

GENERAL COMMENTS

1. **Comment:** **<u>Institutional Controls.</u>**

   a. **The Navy should implement the institutional controls (ICs) according to the Institutional Control Protocol developed by the California Military Environmental Coordination Committee (CMECC). The CMECC Protocol discusses how to incorporate ICs into decision documents, implementation mechanisms such as base master plans and memoranda of agreement, processes for changing ICs, and verification mechanisms.**

   b. **Section 5.3.1 discusses the two options to record the land use restrictions: one is to record them in the Regional Shore Infrastructure Plan (RSIP) for NBVC and the other one is to implement them through a Memorandum of Agreement (MOA) between the Navy and the State. Whether the Navy uses the RSIP or the MOA to record the land use restrictions, it must show that existing processes for land use planning and project approval reference the RSIP or the MOA and that there are adequate checks and balances within the process to ensure adherence to the land use restrictions.**

   c. **Institutional control is a remedy that is subjected to the 5-year review requirement; therefore, the cost of inspection, maintenance, and reporting should be included in the cost estimate.**

   d. **The FS should discuss long term effectiveness and performance of institutional controls in details to show the ICs' adequacy and reliability to prevent incompatible activities to the site remedy. It should also discuss how the ICs meet the requirements of State acceptance of the remedy pursuant to California Health & Safety Code Section 25356.1.**

   Response: Responses to individual comments regarding institutional controls are as follows:

   a. The Navy and the U.S. Environmental Protection Agency (EPA) recently finalized a negotiated agreement on implementation of land use controls entitled "Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and other Post-ROD Action." (Department of the Army 2003). In addition, a similar agreement was also recently implemented among the Environmental Council of States (ECOS), the U.S. Department of Defense (DOD), U.S. Department of the Interior (DOI), U.S. Department of Energy (DOE) and EPA (EPA 2003). The Navy intends to implement ICs according to these agreements.

b. Land use restrictions will be implemented according to the recent agreements outlined in (a) above.

c. The cost of inspecting, maintaining, and reporting for selected remedies including performance of 5-year reviews will be included in the cost estimate for each alternative.

e. The feasibility study (FS) will discuss the long-term effectiveness and performance of institutional controls (IC), to show the ICs' adequacy and reliability to prevent incompatible activities. The FS will also discuss the ICs' compliance with state and federal applicable or relevant and appropriate requirements.

2. **Comment:** **<u>Target Risk Level.</u> The FS states in numerous places that cancer risks less than $1x10^{-4}$ are acceptable for industrial uses. For any exposure setting, DTSC typically finds excess cancer risks of less than $1x10^{-6}$ to be negligible and more than $1x10^{-4}$ to be unacceptable, while those between $1x10^{-6}$ to $1x10^{-4}$ are in the 'risk management range". Excess cancer risks falling between the two benchmarks are not automatically acceptable but require risk management decisions on a case by case basis. This has been the practice of DTSC for many years, not only at this base but also at all military facilities in California.**

Response: The Navy will revise the text in the FS to state that excess cancer risks that fall between 1×10^{-6} to 1×10^{-4} are within the risk management range and that risk management decisions will be made on a case by case basis.

3. **Comment:** **<u>Remedial Action Objectives (RAOs)</u>. The FS calculates RAOs for carcinogens assuming that an excess cancer risk of $1x10^{-4}$ is acceptable for the commercial/industrial exposure setting. DTSC does not accept this. RAOs should be calculated for the point of departure for carcinogenic risk, which is defined in the National Contingency Plan as $1x10^{-6}$. DTSC expects the FS to present RAOs for carcinogens calculated for an excess risk of $1x10^{-6}$. The Navy can present other values for other target risk levels if so desired.**

Response: The Navy will calculate remedial action objectives (RAO) based on target risk levels of 1×10^{-6} and 1×10^{-4} for carcinogens and a target hazard index of 1.0 for noncarcinogens. The FS will be revised to include these RAOs.

4. **Comment:** **<u>IRP Site Descriptions, Section 2.3</u>. Site descriptions provided in this section are inconsistently provided. Consistent details for each site during each investigative phase should be presented concerning the number of borings, the number of samples per borings, the number of monitoring wells and water samples collected, the number of soil gas points surveyed, the parameters analyzed in each medium, and the analytes detected.**

Response: The Navy will revise Section 2.3 to provide a summary of investigation detail regarding the number of soil borings, monitoring wells, and soil gas surveys conducted at each site. This section will also be revised to provide a summary of chemicals of concern at each site and will reference the applicable documents that support this data.

5. **Comment:** **<u>Contaminants of Potential Concern (COPCs) and Contaminants of Potential Ecological Concern (COPECs)</u>. For some sites, summary statements about COPCs are provided in Section 2.3, for others this information is found only in Section 3.0. Statements about COPCs and COPECs for both soil and groundwater should be consistently made in both Sections. In addition, Section 2.3 should reference specific discussions in Section 3.0, which indicates how COPCs and COPECs were eliminated.**

Response: The Navy will revise Sections 2 3 and 3 0 to consistently include summary statements about COPCs and COPECs in both sections for all sites. In addition, Section 2 3 will be revised to indicate where discussion can be found on how COPCs and COPECs were identified

6. **Comment:** **<u>Site 2 Previous investigations - Section 2.3.1.2</u>. Page 2-38 provides a brief summary about the Site Inspection (SI) submitted in 1991, the Phase I Remedial Investigation (Phase I RI) submitted in 1998, the Draft RI Groundwater Study (RIGS) submitted in 1999, and the Draft RI for Groundwater (RIG) submitted in 2001.**

This Section should provide additional key details to the summaries of previous investigations. The summary of each of the four previous investigations should add the following specific information with reference to the specific figure/table and document where the information can be located:

a. **The number of soil borings conducted, the number of soil samples collected from each boring, and the number of soil gas points surveyed**

b. **The COPCs identified for soil**

c. **The number of new wells added to the monitoring well network during the RIGS and how many old and new wells were sampled**

d. **The number of quarterly monitoring events conducted, the dates, and the number of wells included in the network compared to the total number of existing monitoring wells (s)**

Response: The Navy will revise Section 2.3 1.2 to provide additional details to the summaries of previous investigations. The following specific information and references to the specific figure/table or reference document will be included:

a. The number of soil borings conducted, number of soil samples collected, and number of soil gas points surveyed

b A list of the COPCs identified for soil

c. The number of new wells installed during the RIGS and indicate how many new and old wells were sampled during this event

d. The number of sampling events conducted and indicate how many wells were sampled in comparison with the total number of wells on site

7. **Comment:** <u>Site 4 Previous Investigations - Section 2.3.2.2</u>. **The second paragraph on page 2-48 states that the RIGS did not identify any Site 4 locations where groundwater contaminants were detected at levels above the National Ambient Water Quality Criteria and the RIG did not identify any COPCs. These statements should be clarified by restating the removal action that occurred at Site 4, the date of the removal action, the extent and dates of groundwater monitoring conducted prior to the removal action, and the impact to the monitoring well network.**

Response: The Navy will revise the text in Section 2.3.1.2 to include a discussion of the removal action, and clarify the extent and dates of groundwater monitoring conducted before the removal action was performed as well as the impact the removal action had on the monitoring well network.

8. **Comment:** <u>Site 4 Ecological Assessment</u>. **The definitive ecological risk assessment was presented in the documents associated with the removal action and reconstruction of wetland habitat (OHM, 1997), not in the Phase I RI.**

Response: An ecological risk assessment was performed for Site 4, and results were included in the "Phase I Remedial Investigation Technical Memorandum, Naval Air Weapons Station, Point Mugu, California" (PRC 1996). Environmental media evaluated in this ecological risk assessment included surface water as well as soil and sediment to a depth of 3 feet below ground surface An ecological risk assessment was performed to derive ecological risk-based screening levels for potentially deeper dredged materials related to removal actions and the construction of two sand islands. This risk assessment was developed as a result of agency comments to the draft final work plan, dated July 25, 1996 (OHM 1996a), and was presented as Attachment B.V., Final Ecological Risk- Based Screening Levels, in OHM's final work plan dated September 6, 1996 (OHM 1996b).

The Navy will include a discussion of the ecological risk assessment included in the final work plan (OHM 1996b) which presented risk-based screening levels pertaining to the removal action and reconstruction of wetland habitat at IRP Site 4.

9. **Comment:** **Site 8 Previous Investigations - Section 2.3.3.2 Page 2-54 states that groundwater samples collected during the SI indicated the presence of toluene, methylene chloride, endrin, ketone, and inorganic compounds. It also states, however, that during the Phase I RI, no organic contaminants were detected in groundwater.**

   a. **The text should discuss why organic contaminants were detected in 1991 but not detected in 1998. Analytical methods used and detection limits achieved for organic analytes in 1991 and 1998 should be compared. The record should be clear about why organic contaminants were not carried into the RIGS.**

   b. **The text should add a statement about organic and inorganic COPCs and COPECs identified for both soil and groundwater, and reference where discussion can be found on eliminating all COPCs and COPECs. The text states that inorganic contaminants were detected in groundwater during the Phase I RI; no contaminants were carried into the RIGS and RIG, however.**

Response: Responses to individual comments of Site 8 Previous Investigations are as follows:

a. The Navy will revise the text in Section 2.3.3.2 to discuss why the organic contaminants were not detected during the Phase 1 RI at Site 8. The text will be revised to discuss and compare methods and method detection limits for organic analytes used during the 1991 and 1998 events.

b. The Navy will revise the text for Section 2.3.3.2 to list the organic and inorganic COPCs and COPECs identified for both soil and groundwater at Site 8. The section will also be revised to indicate where discussion can be found on how the COPCs and COPECs were identified

10. **Comment:** **<u>Site 9 Phase I RI Activities - Section 2.3.4.3</u>. This Section states the number of soil and groundwater samples collected and the parameters for which the samples were analyzed. The text should state what was detected in soil and groundwater and what COPCs and COPECs were identified.**

Response: The Navy will revise Section 2.3.4.3 to list the chemicals that were detected in soil and groundwater, and identify the chemicals that were identified as COPCs and COPECs.

11. **Comment:** **Figures 3-1 and 3-6. The units of concentration are missing in these Figures, which show the spatial distribution of contaminants.**

Response: The Navy will revise Figures 3-1 and 3-6 to include the units of concentration.

APPENDIX B
MEETINGS MINUTES – INSTALLATION RESTORATION SITES 2, 4, 8, AND 9 APPROACH

Meeting Minutes for Installation Restoration Sites 2, 4, 8 and 9 Feasibility Study Approach
Department of Toxic Substance Control Board
August 21, 2003

Attendees:

Emad Yemut, Department of Toxic Substance Control Board (DTSC)
Peter Chen, DTSC
John Christopher; DTSC; via telephone conference call
Peter Raftery, Los Angeles Regional Water Quality Control Board (LARWQCB); via telephone conference call
Michael Gonzales, Navy Southwest Division (SWDIV)
Steve Granade, Naval Base Ventura County Point Mugu (NBVCPM)
Kathryn Norris, Tetra Tech

Meeting Summary: The Navy discussed the history and current status of the draft Feasibility Study (FS) for Installation Restoration Program (IRP) Sites 2, 4, 8 and 9. In addition, the Navy and its contractor, Tetra Tech, gave a Power Point ™ presentation to the regulatory agencies describing current issues and risk assessment results for the FS being developed for Sites 2, 4, 8 and 9. In the presentation, the Navy identified that the new risk assessment results, performed during the FS show that Sites 4 and 8 have no unacceptable risks and therefore, it is the Navy's position that an FS is not required for these sites. In addition, risk results for Sites 2 and 9 fall within the risk management range. The Navy solicited agency feed-back to determine whether these two sites require action beyond what is already in place.

Discussion After the Presentation:

Following the presentation, Mr. Gonzales opened the floor for discussion and comments.

Dr. Christopher stated that he would need to review the risk assessment calculations and results that he received from the Navy after the meeting. He stated that if he approved of the risk assessment performed by Tetra Tech, then the sites showing no risk should not require an FS. However, he also stated that this policy decision would have to be made by Mr. Chen and Mr. Yemut.

Ms. Norris proposed that because risk results for Sites 4 and 8 showed no unacceptable risk, the sites should be removed from the FS. Ms. Norris also maintained that because risk results for Sites 2 and 9 fell between 1×10^{-4} and 1×10^{-6}, current institutional controls (ICs) in place at NBVCPM made further action unnecessary. She stated that the purpose of an FS is to evaluate remedial action alternatives at a site, and since these sites do not require further action an FS is not required. ICs already in place in the NBVC Regional Shore Infrastructure Plan (RSIP) are adequate for protection at the sites.

Mr. Chen stated that risks associated with Site 9 do require ICs, regardless of the restrictions already in place within facility documentation. Mr. Raftery and Dr. Christopher agreed with Mr. Chen that Site 9 does pose risk and that an FS should be written for this site.

Dr. Christopher stated that if he agreed with the risk results the Navy presented for Site 2, then he would concur with the Navy that Site 2 poses acceptable risk. Dr. Christopher questioned how the risks to the current and future workers at Site 2 were calculated. He said that he would review how the risk assessment was performed before commenting further.

Mr. Raftery requested that the Navy submit references for documents that summarize risks to groundwater at these sites. Ms. Norris and Mr. Granade said that they would compile a reference list and send it to Mr. Raftery via electronic mail.

The Navy and the agencies then discussed the decision-making process for when an FS is required for a site. Ms. Norris stated that if ICs are already in place at a site with manageable risk, and that ICs are the only alternative being evaluated at a site, then, no FS should be needed. Mr. Chen requested that Mr. Yemut attend the meeting to assist in making a decision on the position of DTSC in this matter.

Mr. Yemut entered the meeting and was given a short summary of the meeting issues. Mr. Yemut stated that frequently FS's are developed when ICs are the only alternative. He concurred with Mr. Chen and Dr. Christopher that Site 9 would require ICs and therefore, an FS is required. He also stated that since the draft FS has already been submitted into agency review, then the FS needs to be completed for all of the sites in the draft document. Ms. Norris suggested that the sites identified as having no risk should be removed from the document. Mr. Yemut stated that the sites with no risk should be mentioned in the FS, but could be reduced to a brief summary.

Dr. Christopher stated that he would review the risk calculations and provide comments if he had any.

Mr. Chen stated that he had only seen the responses to comments (RTCs) that the Navy provided via electronic mail. He had not received a hard copy. The other agency attendees concurred that they also had only received an electronic copy of the RTCs. Ms. Norris stated that she would distribute the RTCs in hard copy to all participants.

Mr. Yemut, Mr. Raftery, and Dr. Christopher left the meeting. Mr. Chen then reviewed the risk assessment summary with the Navy. It was decided that a review of the RTCs was not necessary until Mr. Chen received the official hard copy RTCs. Mr. Chen stated that the Navy could remove most of the discussion in the draft FS involving the sites with no risk. However, he requested that the risk results summary for each site remain in the document.

The Navy and Mr. Chen discussed other projects at NBVC and reviewed documents that required priority reviews.

It was agreed that the Navy will retain IR Sites 2, 4, 8, and 9 into next version of the draft final FS, and that for sites with acceptable to no risk (Sites 4 and 8), a brief synopsis of each site will be included with a risk summary table. In addition, if DTSC agrees with the Navy that Site 2 contains acceptable risk, than a brief synopsis of that site will also be included.

The meeting adjourned at 12:00 PM.

APPENDIX C
HHRA BACKUP CALCULATIONS

TABLE C-1: CHEMICALS OF POTENTIAL CONCERN

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Average	RME	SFo	SFi	RfDo	RfDi	ABS	PEF	Uptake Factor	Avg Veg Con	RME Veg Con
Site 2											
Aroclor-1260	0.03695	0.05194	2	2	--	--	0.15	1.32E+09	0.004	0.0001478	0.00020776
Site 8											
DDD	0.00643	0.01048	0.24	0.24	--	--	0.05	1.32E+09	0.013	0.00008359	0.00013624
Site 9											
DDE	0.00812	0.0134	0.34	0.34	--	--	0.05	1.32E+09	0.02	0.0001624	0.000268
DDT	0.0111	0.02093	0.34	0.34	5.00E-04	5.00E-04	0.05	1.32E+09	0.02	0.000222	0.0004186
Aroclor-1260	0.05654	0.08387	2	2	--	--	0.15	1.32E+09	0.004	0.00022616	0.00033548
1,2,3,4,6,7,8-HxCDD	0.00015	0.0007	1.30E+03	1.30E+03	--	--	0.03	1.32E+09	0.005	0.00000075	0.0000035
1,2,3,6,7,8-HxCDD	0.00006	0.00007	1.30E+04	1.30E+04	--	--	0.03	1.32E+09	0.005	0.0000003	0.00000035
1,2,3,6,7,8-HxCDF	0.00005	0.00005	1.30E+04	1.30E+04	--	--	0.03	1.32E+09	0.005	0.00000025	0.00000025
1,2,3,7,8-PCDF	0.00006	0.00006	6.50E+04	6.50E+04	--	--	0.03	1.32E+09	0.005	0.0000003	0.0000003
1,2,3,7,8,9-HxCDF	0.00004	0.00004	1.30E+04	1.30E+04	--	--	0.03	1.32E+09	0.005	0.0000002	0.0000002
2,3,7,8-TCDD	0.00003	0.00004	1.30E+05	1.30E+05	--	--	0.03	1.32E+09	0.005	0.00000015	0.0000002
2,3,7,8-TCDF	0.00003	0.00003	1.30E+04	1.30E+04	--	--	0.03	1.32E+09	0.005	0.00000015	0.00000015
OCDD	0.0026	0.00297	1.30E+02	1.30E+02	--	--	0.03	1.32E+09	0.005	0.000013	0.00001485
OCDF	0.0001	0.0001	1.30E+02	1.30E+02	--	--	0.03	1.32E+09	0.005	0.0000005	0.0000005

TABLE C-2: AVERAGE EXPOSURE PARAMETERS

IRP Sites 2 4, 8, and 9 Feasibility Study, Point Mugu, California

Average Exposure Parameters	Units	Industrial	Residential Adult	Residential Child
Ingestion of Soil				
Ingestion Rate	mg/day	50	100	200
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	3	9	6
Conversion Factor	kg/mg	0 000001	0 000001	0 000001
Body Weight	kg	70	70	15
Averaging Time, Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	1095	3285	2190
Dermal Contact With Soil				
Skin Surface Area	cm2/day	5800	5800	2000
Adherence Factor	mg/cm2	1	1	1
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	3	9	6
Conversion Factor	kg/mg	0 000001	0.000001	0 000001
Body Weight	kg	70	70	15
Averaging Time, Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	1095	3285	2190
Inhalation of Volatiles and Particulates				
Inhalation Rate	m3/day	20	20	10
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	3	9	6
Conversion Factor	kg/mg	0 000001	0 000001	0 000001
Body Weight	kg	70	70	15
Averaging Time Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	1095	3285	2190
Ingestion of Homegrown Produce				
Ingestion Rate, Vegetables[1]	g/day		8 7	3 48
Ingestion Rate, Fruits[1]	g/day		4.872	5 22
Exposure Frequency	days/year		350	350
Exposure Duration	years		9	6
Conversion Factor	kg/g		0 000174	0 000174
Body Weight	kg		70	15
Averaging Time, Carcinogens	days		25550	25550
Averaging Time, Noncarcinogens	days		3285	2190

Notes:

[1] converted from wet weight

TABLE C-3: AVERAGE CANCER RISK AND HAZARD INDEX FOR FUTURE INDUSTRIAL WORKER

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk				Hazard Index			
	Ingestion	Dermal	Inhalation	Total	Ingestion	Dermal	Inhalation	Total
Site 2								
Aroclor-1260	1.5495E-09	2.6961E-08	4.7097E-13	2.8511E-08	--	--	--	--
Site 8								
DDD	3.2357E-11	1.8767E-10	9.8349E-15	2.2004E-10	--	--	--	--
Site 9								
DDE	5.7886E-11	3.3574E-10	1.7595E-14	3.9365E-10	--	--	--	--
DDT	7.9131E-11	4.5896E-10	2.4052E-14	5.3811E-10	1.0861E-05	6.2994E-05	3.3012E-09	7.39E-05
Aroclor-1260	2.371E-09	4.1255E-08	7.2066E-13	4.3627E-08	--	--	--	--
1,2,3,4,6,7,8-HxCDD	4.0886E-09	1.4228E-08	1.2427E-12	1.8318E-08	--	--	--	--
1,2,3,6,7,8-HxCDD	1.6354E-08	5.6914E-08	4.971E-12	7.3273E-08	--	--	--	--
1,2,3,6,7,8-HxCDF	1.3629E-08	4.7428E-08	4.1425E-12	6.1061E-08	--	--	--	--
1,2,3,7,8-PCDF	8.1772E-08	2.8457E-07	2.4855E-11	3.6637E-07	--	--	--	--
1,2,3,7,8,9-HxCDF	1.0903E-08	3.7942E-08	3.314E-12	4.8849E-08	--	--	--	--
2,3,7,8-TCDD	8.1772E-08	2.8457E-07	2.4855E-11	3.6637E-07	--	--	--	--
2,3,7,8-TCDF	8.1772E-09	2.8457E-08	2.4855E-12	3.6637E-08	--	--	--	--
OCDD	7.0869E-09	2.4663E-08	2.1541E-12	3.1752E-08	--	--	--	--
OCDF	2.7257E-10	9.4856E-10	8.2849E-14	1.2212E-09	--	--	--	--
Total	**2.2656E-07**	**8.2177E-07**	**6.8865E-11**	**1.0484E-06**	**1.0861E-05**	**6.2994E-05**	**3.3012E-09**	**7.39E-05**

TABLE C-4: AVERAGE CANCER RISK AND HAZARD INDEX FUTURE RESIDENTIAL ADULT

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk					Hazard Index				
	Ingestion	Dermal	Inhalation	Produce	Total	Ingestion	Dermal	Inhalation	Produce	Total
Site 2										
Aroclor-1260	1.3016E-08	1.1324E-07	1.9781E-12	1.2295E-09	1.2748E-07	--	--	--	--	--
Site 8										
DDD	2.718E-10	7.8821E-10	4.1306E-14	8.3441E-11	1.1435E-09	--	--	--	--	--
Site 9										
DDE	4.8625E-10	1.4101E-09	7.3898E-14	2.2966E-10	2.1261E-09	--	--	--	--	--
DDT	6.647E-10	1.9276E-09	1.0102E-13	3.1394E-10	2.9064E-09	3.0411E-05	8.8192E-05	4.6217E-09	1.436E-05	1.19E-04
Aroclor-1260	1.9916E-08	1.7327E-07	3.0268E-12	1.8813E-09	1.9507E-07	--	--	--	--	--
1,2,3,4,6,7,8-HxCDD	3.4344E-08	5.9759E-08	5.2195E-12	4.0553E-09	9.8164E-08	--	--	--	--	--
1,2,3,6,7,8-HxCDD	1.3738E-07	2.3904E-07	2.0878E-11	1.6221E-08	3.9266E-07	--	--	--	--	--
1,2,3,6,7,8-HxCDF	1.1448E-07	1.992E-07	1.7398E-11	1.3518E-08	3.2721E-07	--	--	--	--	--
1,2,3,7,8-PCDF	6.8689E-07	1.1952E-06	1.0439E-10	8.1105E-08	1.9633E-06	--	--	--	--	--
1,2,3,7,8,9-HxCDF	9.1585E-08	1.5936E-07	1.3919E-11	1.0814E-08	2.6177E-07	--	--	--	--	--
2,3,7,8-TCDD	6.8689E-07	1.1952E-06	1.0439E-10	8.1105E-08	1.9633E-06	--	--	--	--	--
2,3,7,8-TCDF	6.8689E-08	1.1952E-07	1.0439E-11	8.1105E-09	1.9633E-07	--	--	--	--	--
OCDD	5.953E-08	1.0358E-07	9.0472E-12	7.0291E-09	1.7015E-07	--	--	--	--	--
OCDF	2.2896E-09	3.984E-09	3.4797E-13	2.7035E-10	6.5443E-09	--	--	--	--	--
Total	**1.9031E-06**	**3.4514E-06**	**2.8923E-10**	**2.2465E-07**	**5.5795E-06**	**3.0411E-05**	**8.8192E-05**	**4.6217E-09**	**1.436E-05**	**1.19E-04**

TABLE C-5: AVERAGE CANCER RISK AND HAZARD INDEX FOR FUTURE RESIDENTIAL CHILD

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk					Hazard Index				
	Ingestion	Dermal	Inhalation	Produce	Total	Ingestion	Dermal	Inhalation	Produce	Total
Site 2										
Aroclor-1260	8.0986E-08	1.2148E-07	3.077E-12	2.4519E-09	2.0492E-07	--	--	--	--	--
Site 8										
DDD	1.6912E-09	8.4559E-10	6.4254E-14	1.6641E-10	2.7032E-09	--	--	--	--	--
Site 9										
DDE	3.0255E-09	1.5128E-09	1.1495E-13	4.5801E-10	4.9964E-09	--	--	--	--	--
DDT	4.1359E-09	2.0679E-09	1.5714E-13	6.2609E-10	6.8301E-09	0.00028384	0.00014192	1.0784E-08	4.297E-05	4.26E-04
Aroclor-1260	1.2392E-07	1.8588E-07	4.7083E-12	3.7519E-09	3.1356E-07	--	--	--	--	--
1,2,3,4,6,7,8-HxCDD	2.137E-07	6.411E-08	8.1192E-12	8.0874E-09	2.859E-07	--	--	--	--	--
1,2,3,6,7,8-HxCDD	8.5479E-07	2.5644E-07	3.2477E-11	3.235E-08	1.1436E-06	--	--	--	--	--
1,2,3,6,7,8-HxCDF	7.1233E-07	2.137E-07	2.7064E-11	2.6958E-08	9.5301E-07	--	--	--	--	--
1,2,3,7,8-PCDF	4.274E-06	1.2822E-06	1.6238E-10	1.6175E-07	5.7181E-06	--	--	--	--	--
1,2,3,7,8,9-HxCDF	5.6986E-07	1.7096E-07	2.1651E-11	2.1566E-08	7.6241E-07	--	--	--	--	--
2,3,7,8-TCDD	4.274E-06	1.2822E-06	1.6238E-10	1.6175E-07	5.7181E-06	--	--	--	--	--
2,3,7,8-TCDF	4.274E-07	1.2822E-07	1.6238E-11	1.6175E-08	5.7181E-07	--	--	--	--	--
OCDD	3.7041E-07	1.1112E-07	1.4073E-11	1.4018E-08	4.9557E-07	--	--	--	--	--
OCDF	1.4247E-08	4.274E-09	5.4128E-13	5.3916E-10	1.906E-08	--	--	--	--	--
Total	**1.1842E-05**	**3.7027E-06**	**4.4992E-10**	**4.4803E-07**	**1.5993E-05**	**0.00028384**	**0.00014192**	**1.0784E-08**	**4.297E-05**	**4.26E-04**

TABLE C-6: AVERAGE TOTAL FUTURE RESIDENTIAL CANCER RISK

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk				
	Ingestion	Dermal	Inhalation	Produce	Total
Site 2					
Aroclor-1260	9.4002E-08	2.3472E-07	5.0551E-12	3.6814E-09	3.324E-07
Site 8					
DDD	1.963E-09	1.6338E-09	1.0556E-13	2.4985E-10	3.8467E-09
Site 9					
DDE	3.5118E-09	2.9229E-09	1.8885E-13	6.8766E-10	7.1225E-09
DDT	4.8006E-09	3.9956E-09	2.5816E-13	9.4003E-10	9.7364E-09
Aroclor-1260	1.4384E-07	3.5916E-07	7.7351E-12	5.6332E-09	5.0864E-07
1,2,3,4,6,7,8-HxCDD	2.4804E-07	1.2387E-07	1.3339E-11	1.2143E-08	3.8407E-07
1,2,3,6,7,8-HxCDD	9.9217E-07	4.9548E-07	5.3355E-11	4.8571E-08	1.5363E-06
1,2,3,6,7,8-HxCDF	8.2681E-07	4.129E-07	4.4463E-11	4.0476E-08	1.2802E-06
1,2,3,7,8-PCDF	4.9609E-06	2.4774E-06	2.6678E-10	2.4285E-07	7.6814E-06
1,2,3,7,8,9-HxCDF	6.6145E-07	3.3032E-07	3.557E-11	3.2381E-08	1.0242E-06
2,3,7,8-TCDD	4.9609E-06	2.4774E-06	2.6678E-10	2.4285E-07	7.6814E-06
2,3,7,8-TCDF	4.9609E-07	2.4774E-07	2.6678E-11	2.4285E-08	7.6814E-07
OCDD	4.2994E-07	2.1471E-07	2.3121E-11	2.1047E-08	6.6572E-07
OCDF	1.6536E-08	8.2579E-09	8.8925E-13	8.0951E-10	2.5605E-08
Total	**1.3745E-05**	**7.1541E-06**	**7.3915E-10**	**6.7268E-07**	**2.1572E-05**

TABLE C-7:
RME EXPOSURE PARAMETERS
IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

RME Exposure Parameters	Units	Industrial	Residential Adult	Residential Child
Ingestion of Soil				
Ingestion Rate	mg/day	50	100	200
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	24	6
Conversion Factor	kg/mg	0 000001	0 000001	0 000001
Body Weight	kg	70	70	15
Averaging Time Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	9125	8760	2190
Dermal Contact With Soil				
Skin Surface Area	cm2/day	5800	5800	2000
Adherence Factor	mg/cm2	1	1	1
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	24	6
Conversion Factor	kg/mg	0 000001	0 000001	0 000001
Body Weight	kg	70	70	15
Averaging Time Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	9125	8760	2190
Inhalation of Volatiles and Particulates				
Inhalation Rate	m3/day	20	20	10
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	24	6
Conversion Factor	kg/mg	0 000001	0 000001	0 000001
Body Weight	kg	70	70	15
Averaging Time, Carcinogens	days	25550	25550	25550
Averaging Time, Noncarcinogens	days	9125	8760	2190
Ingestion of Homegrown Produce				
Ingestion Rate, Vegetables[1]	g/day		13 92	6 96
Ingestion Rate, Fruits[1]	g/day		7.308	10 614
Exposure Frequency	days/year		350	350
Exposure Duration	years		24	6
Conversion Factor	kg/g		0.001	0 001
Body Weight	kg		70	15
Averaging Time, Carcinogens	days		25550	25550
Averaging Time, Noncarcinogens	days		8760	2190

Notes:

[1] converted from wet weight

TABLE C-8: RME CANCER RISK AND HAZARD INDEX FOR FUTURE INDUSTRIAL WORKER

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk				Hazard Index			
	Ingestion	Dermal	Inhalation	Total	Ingestion	Dermal	Inhalation	Total
Site 2								
Aroclor-1260	1.8151E-08	3.1582E-07	5.5169E-12	3.3398E-07	--	--	--	--
Site 8								
DDD	4.3947E-10	2.549E-09	1.3358E-13	2.9886E-09	--	--	--	--
Site 9								
DDE	7.9606E-10	4.6171E-09	2.4196E-13	5.4134E-09	--	--	--	--
DDT	1.2434E-09	7.2117E-09	3.7793E-13	8.4555E-09	2.0479E-05	0.00011878	6.2248E-09	1.39E-04
Aroclor-1260	2.9309E-08	5.0997E-07	8.9084E-12	5.3929E-07	--	--	--	--
1,2,3,4,6,7,8-HxCDD	1.59E-07	5.5333E-07	4.8329E-11	7.1238E-07	--	--	--	--
1,2,3,6,7,8-HxCDD	1.59E-07	5.5333E-07	4.8329E-11	7.1238E-07	--	--	--	--
1,2,3,6,7,8-HxCDF	1.1357E-07	3.9523E-07	3.4521E-11	5.0884E-07	--	--	--	--
1,2,3,7,8-PCDF	6.8144E-07	2.3714E-06	2.0712E-10	3.053E-06	--	--	--	--
1,2,3,7,8,9-HxCDF	9.0858E-08	3.1619E-07	2.7616E-11	4.0707E-07	--	--	--	--
2,3,7,8-TCDD	9.0858E-07	3.1619E-06	2.7616E-10	4.0707E-06	--	--	--	--
2,3,7,8-TCDF	6.8144E-08	2.3714E-07	2.0712E-11	3.053E-07	--	--	--	--
OCDD	6.7462E-08	2.3477E-07	2.0505E-11	3.0225E-07	--	--	--	--
OCDF	2.2715E-09	7.9047E-09	6.9041E-13	1.0177E-08	--	--	--	--
Total	**2.2817E-06**	**8.353E-06**	**6.9352E-10**	**1.0635E-05**	**2.0479E-05**	**0.00011878**	**6.2248E-09**	**1.39E-04**

TABLE C-9: RME CANCER RISK AND HAZARD INDEX FOR RESIDENTIAL ADULT

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk					Hazard Index				
	Ingestion	Dermal	Inhalation	Produce	Total	Ingestion	Dermal	Inhalation	Produce	Total
Site 2										
Aroclor-1260	4.8789E-08	4.2446E-07	7.4147E-12	4.1428E-08	5.1469E-07	--	--	--	--	--
Site 8										
DDD	1.1813E-09	3.4258E-09	1.7953E-13	3.26E-09	7.8673E-09	--	--	--	--	--
Site 9										
DDE	2.1398E-09	6.2054E-09	3.252E-13	9.0848E-09	1.743E-08	--	--	--	--	--
DDT	3.3422E-09	9.6925E-09	5.0794E-13	1.419E-08	2.7225E-08	5.7342E-05	0.00016629	8.7147E-09	2.435E-04	2.24E-04
Aroclor-1260	7.8782E-08	6.854E-07	1.1973E-11	6.6895E-08	8.3109E-07	--	--	--	--	--
1,2,3,4,6,7,8-HxCDD	4.274E-07	7.4367E-07	6.4954E-11	4.5364E-07	1.6248E-06	--	--	--	--	--
1,2,3,6,7,8-HxCDD	4.274E-07	7.4367E-07	6.4954E-11	4.5364E-07	1.6248E-06	--	--	--	--	--
1,2,3,6,7,8-HxCDF	3.0528E-07	5.3119E-07	4.6396E-11	3.2403E-07	1.1606E-06	--	--	--	--	--
1,2,3,7,8-PCDF	1.8317E-06	3.1872E-06	2.7837E-10	1.9442E-06	6.9633E-06	--	--	--	--	--
1,2,3,7,8,9-HxCDF	2.4423E-07	4.2495E-07	3.7117E-11	2.5922E-07	9.2844E-07	--	--	--	--	--
2,3,7,8-TCDD	2.4423E-06	4.2495E-06	3.7117E-10	2.5922E-06	9.2844E-06	--	--	--	--	--
2,3,7,8-TCDF	1.8317E-07	3.1872E-07	2.7837E-11	1.9442E-07	6.9633E-07	--	--	--	--	--
OCDD	1.8134E-07	3.1553E-07	2.7559E-11	1.9247E-07	6.8937E-07	--	--	--	--	--
OCDF	6.1057E-09	1.0624E-08	9.2791E-13	6.4806E-09	2.3211E-08	--	--	--	--	--
Total	**6.1332E-06**	**1.1226E-05**	**9.3209E-10**	**6.5105E-06**	**2.3871E-05**	**5.7342E-05**	**0.00016629**	**8.7147E-09**	**2.435E-04**	**2.24E-04**

TABLE C-10: RME CANCER RISK AND HAZARD INDEX FOR FUTURE RESIDENTIAL CHILD

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk					Hazard Index				
	Ingestion	Dermal	Inhalation	Produce	Total	Ingestion	Dermal	Inhalation	Produce	Total
Site 2										
Aroclor-1260	1.1384E-07	1.7076E-07	4.3253E-12	4.0013E-08	3.2462E-07	--	--	--	--	--
Site 8										
DDD	2.7564E-09	1.3782E-09	1.0473E-13	3.1486E-09	7.2833E-09	--	--	--	--	--
Site 9										
DDE	4.9929E-09	2.4964E-09	1.897E-13	8.7745E-09	1.6264E-08	--	--	--	--	--
DDT	7.7986E-09	3.8993E-09	2.963E-13	1.3705E-08	2.5403E-08	0.0005352	0.0002676	2.0334E-08	9.406E-04	8.03E-04
Aroclor-1260	1.8382E-07	2.7574E-07	6.9842E-12	6.4611E-08	5.2418E-07	--	--	--	--	--
1,2,3,4,6,7,8-HxCDD	9.9726E-07	2.9918E-07	3.789E-11	4.3815E-07	1.7346E-06	--	--	--	--	--
1,2,3,6,7,8-HxCDD	9.9726E-07	2.9918E-07	3.789E-11	4.3815E-07	1.7346E-06	--	--	--	--	--
1,2,3,6,7,8-HxCDF	7.1233E-07	2.137E-07	2.7064E-11	3.1296E-07	1.239E-06	--	--	--	--	--
1,2,3,7,8-PCDF	4.274E-06	1.2822E-06	1.6238E-10	1.8778E-06	7.4341E-06	--	--	--	--	--
1,2,3,7,8,9-HxCDF	5.6986E-07	1.7096E-07	2.1651E-11	2.5037E-07	9.9121E-07	--	--	--	--	--
2,3,7,8-TCDD	5.6986E-06	1.7096E-06	2.1651E-10	2.5037E-06	9.9121E-06	--	--	--	--	--
2,3,7,8-TCDF	4.274E-07	1.2822E-07	1.6238E-11	1.8778E-07	7.4341E-07	--	--	--	--	--
OCDD	4.2312E-07	1.2694E-07	1.6076E-11	1.859E-07	7.3598E-07	--	--	--	--	--
OCDF	1.4247E-08	4.274E-09	5.4128E-13	6.2592E-09	2.478E-08	--	--	--	--	--
Total	**1.4311E-05**	**4.5164E-06**	**5.4372E-10**	**6.2881E-06**	**2.5116E-05**	**0.0005352**	**0.0002676**	**2.0334E-08**	**9.406E-04**	**8.03E-04**

TABLE C-11: RME TOTAL FUTURE RESIDENTIAL CANCER RISK

IRP Sites 2, 4, 8, and 9 Feasibility Study, Point Mugu, California

COPC	Cancer Risk				
	Ingestion	Dermal	Inhalation	Produce	Total
Site 2					
Aroclor-1260	1.6263E-07	5.9523E-07	1.174E-11	8.1441E-08	8.3931E-07
Site 8	**Cancer Risk**				
DDD	3.9377E-09	4.804E-09	2.8426E-13	6.4086E-09	1.5151E-08
Site 9	**Cancer Risk**				
DDE	7.1327E-09	8.7019E-09	5.149E-13	1.7859E-08	3.3694E-08
DDT	1.1141E-08	1.3592E-08	8.0424E-13	2.7895E-08	5.2628E-08
Aroclor-1260	2.6261E-07	9.6114E-07	1.8957E-11	1.3151E-07	1.3553E-06
1,2,3,4,6,7,8-HxCDD	1.4247E-06	1.0428E-06	1.0284E-10	8.9179E-07	3.3594E-06
1,2,3,6,7,8-HxCDD	1.4247E-06	1.0428E-06	1.0284E-10	8.9179E-07	3.3594E-06
1,2,3,6,7,8-HxCDF	1.0176E-06	7.4489E-07	7.346E-11	6.3699E-07	2.3996E-06
1,2,3,7,8-PCDF	6.1057E-06	4.4694E-06	4.4076E-10	3.8219E-06	1.4397E-05
1,2,3,7,8,9-HxCDF	8.1409E-07	5.9591E-07	5.8768E-11	5.0959E-07	1.9197E-06
2,3,7,8-TCDD	8.1409E-06	5.9591E-06	5.8768E-10	5.0959E-06	1.9197E-05
2,3,7,8-TCDF	6.1057E-07	4.4694E-07	4.4076E-11	3.8219E-07	1.4397E-06
OCDD	6.0446E-07	4.4247E-07	4.3635E-11	3.7837E-07	1.4253E-06
OCDF	2.0352E-08	1.4898E-08	1.4692E-12	1.274E-08	4.7991E-08
Total	**2.0444E-05**	**1.5743E-05**	**1.4758E-09**	**1.2799E-05**	**4.8987E-05**

APPENDIX D
COST ESTIMATES

Point Mugu – Sites 2, 4, 8 and 9 Feasibility Study
Site 9 Alternative Cost Components

Alternative 1 – No Further Action.

Alternative 2 – Institutional Controls

Institutional Controls Include:
- Regional Shore Infrastructure Plan
- Memorandum of Agreement (including negotiations with the state)
- Signage

Annual Operations and Maintenance (O&M) Includes:
- Once per year site inspection and maintenance of signage.

5-Year Review Includes:
- Site inspection, document review and interviews
- Report preparation

Present Value Analysis – Actual costs include a 25 percent contingency factor and are rounded to the nearest $100.

Capital Costs (Year 0)
- Institutional Controls ($42,200)

Annual O&M Costs
- Site Inspection and Maintenance($4,900 [beginning in year 1])

Periodic Costs ($15,600 [Years 5, 10, 15, 20, 25 and 30])
- 5-Year Review

Total Annual Cost
- Sum of the total cost per year

Present Value Cost (Assuming a 3.2 percent discount factor and 0 percent inflation factor)
- Present value of the total cost per year

Cost Estimate Sheets

TABLE D-1
Cost Estimate for IRP Site 9
Alternative 2: Land Use Controls

Naval Base Ventura County, Point Mugu, California

Item	Unit		Unit Cost	Quantity		Cost	Source of Cost Data
CAPITAL COSTS							
Regional Shore Infrastructure Plan	ea	$	10 000 00	1	$	10 000	Lump Sum Estimate for Each Site
Memorandum of Agreement	ea	$	15 000 00	1	$	15 000	Lump Sum Estimate for Each Site
Signage	ea	$	103 00	4	$	412	RACER
				SUBTOTAL	$	25 412	
Contingencies	25%				$	6 353	10% Scope 15% Bid
				SUBTOTAL	$	31 765	
Project Management	8%				$	2 541	EPA Cost Guidance
Remedial Design	15%				$	4 765	EPA Cost Guidance
Construction Management	10%				$	3 177	EPA Cost Guidance
				SUBTOTAL	$	10 482	
TOTAL CAPITAL COSTS					**$**	**42,247**	
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS							
Site Inspections and Sign Maintenance	ls	$	3 938	1	$	3 938	RACER
				SUBTOTAL	$	3 938	
O&M Contingencies	25%				$	985	10% Scope 15% Bid
TOTAL YEARLY O&M COST					**$**	**4,923**	
PERIODIC COSTS							
5-Year Review	ls	$	12 515	1	$	12 515	RACER
				SUBTOTAL	$	12 515	
Contingencies	25%				$	3 129	10% Scope 15% Bid
TOTAL PERIODIC COST					**$**	**15,644**	

Notes
ls = lump sum
ea = each

TABLE D-1
Cost Estimate for IRP Site 9
Alternative 2: Land Use Controls

Naval Base Ventura County, Point Mugu, California

Present Value Analysis

Year	Capital Costs	O&M Costs	Periodic Costs	Total Annual Expenditures	Discount Factor (3.2%)	Present Value
0	$ 42,247	0	0	$ 42,247	1	$ 42,247
1	0	$ 4,923	0	$ 4,923	0.9690	$ 4,770
2	0	$ 4,923	0	$ 4,923	0.9389	$ 4,622
3	0	$ 4,923	0	$ 4,923	0.9098	$ 4,479
4	0	$ 4,923	0	$ 4,923	0.8816	$ 4,340
5	0	$ 4,923	$ 15,644	$ 20,566	0.8543	$ 17,569
6	0	$ 4,923	0	$ 4,923	0.8278	$ 4,075
7	0	$ 4,923	0	$ 4,923	0.8021	$ 3,948
8	0	$ 4,923	0	$ 4,923	0.7773	$ 3,826
9	0	$ 4,923	0	$ 4,923	0.7532	$ 3,707
10	0	$ 4,923	$ 15,644	$ 20,566	0.7298	$ 15,009
11	0	$ 4,923	0	$ 4,923	0.7072	$ 3,481
12	0	$ 4,923	0	$ 4,923	0.6852	$ 3,373
13	0	$ 4,923	0	$ 4,923	0.6640	$ 3,269
14	0	$ 4,923	0	$ 4,923	0.6434	$ 3,167
15	0	$ 4,923	$ 15,644	$ 20,566	0.6235	$ 12,822
16	0	$ 4,923	0	$ 4,923	0.6041	$ 2,974
17	0	$ 4,923	0	$ 4,923	0.5854	$ 2,882
18	0	$ 4,923	0	$ 4,923	0.5672	$ 2,792
19	0	$ 4,923	0	$ 4,923	0.5496	$ 2,706
20	0	$ 4,923	$ 15,644	$ 20,566	0.5326	$ 10,954
21	0	$ 4,923	0	$ 4,923	0.5161	$ 2,540
22	0	$ 4,923	0	$ 4,923	0.5001	$ 2,462
23	0	$ 4,923	0	$ 4,923	0.4846	$ 2,385
24	0	$ 4,923	0	$ 4,923	0.4696	$ 2,311
25	0	$ 4,923	$ 15,644	$ 20,566	0.4550	$ 9,358
26	0	$ 4,923	0	$ 4,923	0.4409	$ 2,170
27	0	$ 4,923	0	$ 4,923	0.4272	$ 2,103
28	0	$ 4,923	0	$ 4,923	0.4140	$ 2,038
29	0	$ 4,923	0	$ 4,923	0.4011	$ 1,975
30	0	$ 4,923	$ 15,644	$ 20,566	0.3887	$ 7,994
TOTALS:	$ 42,247	$ 147,675	$ 93,863	$ 283,785		$ 192,348
PV:	$ 42 247	$ 94 036	$ 56 065	$ 192 348		
			TOTAL PRESENT VALUE			**$ 192,300**

Notes:
1 Capital costs are assumed to occur in year zero.
2 Total annual expenditure is the total cost per year with no discounting.
3 Present value (PV) is the total cost per year including a 3 2% discount factor for that year.
4 Total present value is rounded to the nearest $100

RACER Reports

Technology Detail Report
(with Markups)

Folder: Point Mugu IRP Sites 2, 4, 8 & 9

Site

Name: IRP Site 9
ID: Naval Base Ventura County Point Mugu
Location: PT MUGU CALIFORNIA

Modifiers:			
	Material	1 117	(Modified)
	Labor	1 103	(Modified)
	Equipment	1 154	(Modified)

Category: None
Report Option: Calendar Year

Remedial Alternative

Name: Alternative 2 - Land Use Controls
ID: Alternative 2
Type: None
Description: Land Use Controls (Site 9 only)

Phase Element

Name: Alternative 2 - Land Use Controls
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: None
Description: LUCs Site 9 Only

Media/Waste Type: Groundwater
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: None
Markup Template: System Defaults

Technology

Name: SIGNAGE
Prime Markup: 100 %
Sub Markup: 0 %

Technology Detail Report
(with Markups)

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18040501	Hazardous Waste Signing	1 00	EA	28.23	74 38	0 00	$102 61	☐
					Total Technology Cost		$102.61	

Technology Detail Report
(with Markups)

Folder: Point Mugu IRP Sites 2, 4, 8 & 9

Site

Name: IRP Site 9
ID: Naval Base Ventura County Point Mugu
Location: PT MUGU CALIFORNIA

Modifiers:			
	Material	1 117	(Modified)
	Labor	1 103	(Modified)
	Equipment	1 154	(Modified)

Category: None Label45
Report Option: Calendar Year

Remedial Alternative

Name: Alternative 2 - Land Use Controls
ID: Alternative 2
Type: None
Description: Land Use Controls (Sites 2 and 9 only)

Phase Element

Name: Alternative 2 - Land Use Controls
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: None
Description: LUCs Site 9 Only

Media/Waste Type: Groundwater
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: None
Markup Template: System Defaults

Technology

Name: Site Inspection
Prime Markup: 100 %
Sub Markup: 0 %

Cost Database Date: 2003
Cost Type: System
Print Date: 1/26/2004 3:34:08 PM

Technology Detail Report
(with Markups)

Element: Planning

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	5 00	HR	0 00	172 43	0.00	$862 13	☐
33220109	Staff Scientist	16 00	HR	0 00	99.07	0.00	$1 585 10	☐
33240101	Other Direct Costs	1.00	LS	21.47	0.00	0.00	$21.47	☑
					Total Element Cost		$2,468.70	

Element: Site Investigation

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	3 00	HR	0 00	172 43	0 00	$517.28	☐
33220109	Staff Scientist	6 00	HR	0 00	99 07	0 00	$594 41	☐
33220114	Word Processing/Clerical	6.00	HR	0 00	57 40	0 00	$344 40	☐
33240101	Other Direct Costs	1.00	LS	12.77	0.00	0.00	$12.77	☑
					Total Element Cost		$1,468 87	

Total Technology Cost	$3,937.57

Technology Detail Report
(with Markups)

Folder: Point Mugu IRP Sites 2, 4, 8 & 9

Site

Name: IRP Site 9
ID: Naval Base Ventura County Point Mugu
Location: PT MUGU CALIFORNIA
Modifiers:

Material	1 117	(Modified)
Labor	1 103	(Modified)
Equipment	1 154	(Modified)

Category: None
Report Option: Calendar Year

Remedial Alternative

Name: Alternative 2 - Land Use Controls
ID: Alternative 2
Type: None
Description: Land Use Controls (Site 9 only)

Phase Element

Name: Alternative 2 - Land Use Controls
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: None
Description: LUCs Site 9 Only

Media/Waste Type: Groundwater
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: None
Markup Template: System Defaults

Technology

Name: Five-Year Review
Prime Markup: 100 %
Sub Markup: 0 %

Technology Detail Report
(with Markups)

Element: Document Review

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220105	Project Engineer	5 00	HR	0 00	127.66	0 00	$638.28	☐
33220108	Project Scientist	4 00	HR	0.00	103 79	0.00	$415 15	☐
33220109	Staff Scientist	8.00	HR	0.00	99.07	0.00	$792.55	☐

Total Element Cost $1 845.99

Element: Interviews

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	11.00	HR	0.00	172.43	0.00	$1,896.69	☐

Total Element Cost $1,896 69

Element: Site Inspection

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	4 00	HR	0 00	172 43	0.00	$689 71	☐
33220105	Project Engineer	4 00	HR	0 00	127.66	0 00	$510.63	☐
33220108	Project Scientist	4.00	HR	0.00	103 79	0 00	$415 15	☐
33220109	Staff Scientist	4.00	HR	0.00	99.07	0.00	$396.28	☐

Total Element Cost $2,011.76

Cost Database Date: 2003

Cost Type: System

Print Date: 12/31/2003 3:27:49 PM

Technology Detail Report
(with Markups)

Element: Report

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	5.00	HR	0 00	172.43	0.00	$862.13	☐
33220105	Project Engineer	14 00	HR	0 00	127.66	0.00	$1 787 19	☐
33220108	Project Scientist	12.00	HR	0 00	103 79	0.00	$1 245.46	☐
33220109	Staff Scientist	24.00	HR	0.00	99.07	0.00	$2,377.65	☐
					Total Element Cost		$6.272.44	

Element: Travel

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010108	Sedan Automobile Rental	2 00	DAY	74.09	0.00	0 00	$148 17	☐
33010202	Per Diem (per person)	4 00	DAY	85.00	0.00	0.00	$340 00	☑
33041101	Airfare	2.00	LS	0.00	0.00	0.00	$0.00	☐
					Total Element Cost		$488.17	

Total Technology Cost $12,515.06

Cost Database Date: 2003
Cost Type: System
Print Date: 12/31/2003 3:27:49 PM

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